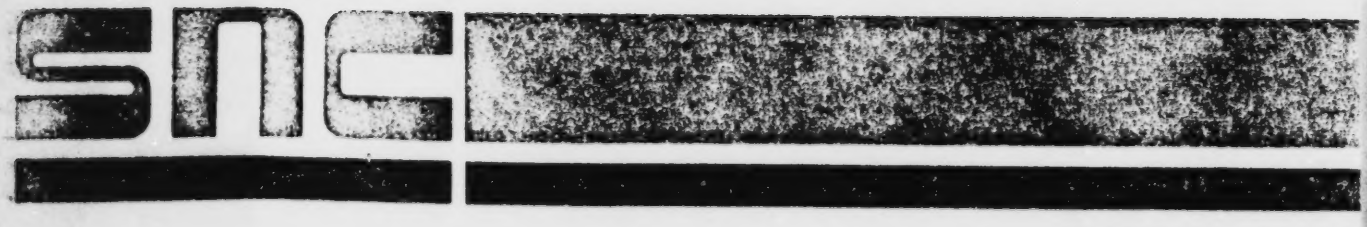
3-9136



Supply and Services Canada / Approvisionnements et Services Canada

REQUEST FOR PROPOSAL — DEMANDE DE PROPOSITION

Page 1 Of De 12

Date of Solicitation – Date de Sollicitation
February 14,1983

Solicitation closes – Sollicitation expire
At – À 10AM EST On – Le March 31,1983

DSS File No. – Dossier MAS N°
15SQ.23440-2-Bitumen-X

Delivery Date req. at dest. – Date de liv. demandée

INSPECTION
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Dr. R.G. Agarwal

Area Code & Tel. No. (819/613) 997-7420
Code régional et n° tél.

SNC Inc.
Attn: Dr. N.E. Cooke/Mr. Z.A. Siddiqui
Box 10
1 Complexe Desjardins
Montreal, Quebec

Destination

If your name and/or address is incorrect, show corrections on reverse side. Si votre nom et (ou) adresse est inexact inscrivez les corrections au verso.

RETURN ORIGINAL – RENVOYER L'ORIGINAL

Submit this form with your proposal. (Return envelope provided.) Return to The Secretary, Supply Administration, Department of Supply and Services, Room 1-335, Place du Portage, 11 Laurier Street, Hull, Quebec K1A 1C9

Renvoyer cette formule avec votre proposition, en utilisant l'enveloppe fournie, au Secrétaire, Administration des Approvisionnements, Ministère des Approvisionnements et Services, Pièce 1-335, Place du Portage, 11, rue Laurier, Hull (Québec) K1A 1C9

Item Article	Description	Price Prix

TITLE

TREATMENT OF BITUMEN/OIL EMULSIONS AND EFFLUENT WATERS

IMPORTANT

Please note Clause 9.0 which sets out conditions relating to:

i) Acceptance of telex/telegraphic Bids.
ii) Method of requesting time extension to closing date.
iii) Validation of date and time of respondent RFP's.

1.0 OBJECTIVES OF THE PROGRAM

1.1 To improve recovery of bitumen or heavy oil from wellhead production fluids arising from commercial in-situ thermal recovery projects.

1.2 To scavenge oil and otherwise improve the quality of produced waters, from in-situ thermal recovery projects, for reuse (e.g. steam generation) or disposal.

219 pp

MICROMEDIA

INSTRUCTIONS

1. Quote in Canadian currency.
2. Municipal taxes are not applicable. For Provincial taxes see reverse.
3. All prices are to include applicable Canadian customs duties, excise taxes and federal sales tax.
4. All prices are to include packing, packaging and all delivery charges F.O.B. destination(s) specified herein.

1. Les prix doivent être indiqués en devises canadiennes.
2. Les taxes municipales ne s'appliquent pas; pour les dispositions sur les taxes provinciales, voir au verso.
3. Tous les prix indiqués doivent comprendre les droits de douane canadiens la taxe d'accise et la taxe fédérale de vente.
4. Tous les prix doivent comprendre les frais d'emballage, d'empaquetage et de livraison F.A.B. à la destination indiquée ci-dessus.

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Nom et titre de la personne autorisée à signer (Dactylo ou majuscules)

This proposal is submitted upon the Terms and Conditions set out herein and on the reverse side hereof.

Cette proposition est présentée suivant les conditions exposées dans les présent et au verso des présentes.

ZAFAR SIDDIQI, PROJ. MGR
NAME – NOM TITLE – TITRE

Zafar S. Siddiqui
SIGNATURE

DSS-MAS 9452 (5/79)

SNC

Bid Receiving
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Téléphone (514) 282-9551

Adresse télégraphique SNCINC
Telex 055-60042

SNC Inc.

March 29, 1983

DSS File No. 15SQ.23440-2-BITUMEN-X
SNC File No. 8832

The Secretary
Supply Administration
Supply and Services Canada
Room 1-335
Place du Portage, Phase III
11, Laurier Street
Hull, Quebec
K1A 1C9

Re: Treatment of Bitumen/Oil Emulsion and Effluent Waters

Gentlemen:

The SNC Group takes pleasure in presenting the following proposal in response to your request for proposal on the above program.

- Authoritative Review and Critical Assessment of Commercial and Emerging Technologies for the Separation of Stable Oil/Water/Mineral Emulsions with Emphasis on Bitumen and Heavy Oil Application

The teams which we have proposed for these studies have been carefully formed to cover all aspects of the study. We believe we have assembled the most knowledgeable personnel in the field of bitumen/oil emulsions and effluent water.

The SNC Technical Development Department has in the recent past undertaken both theoretical and experimental work in the energy field and, in particular, it has carried out a number of major technical and economic studies in various technologies. The SNC Technical Development Department retains a team of specialists and is able to provide their expertise and multifaceted experiences to undertake all phases of the work. In addition, SNC is able to provide well equipped facilities to undertake experimental work for the project.

If there are any questions arising from this proposal, please call me at (514) 282-9551.

We look forward to serving you.

Yours sincerely,

N.E. Cooke, Eng. Sc.D.
Manager
Technical Development Department

3-9136

CONTRACT REPORT NO. 05Q83-00124

PROPOSAL

FOR

AUTHORITATIVE REVIEW AND CRITICAL ASSESSMENT OF COMMERCIAL AND EMERGING TECHNOLOGIES FOR THE SEPARATION OF STABLE OIL/WATER/MINERAL EMULSIONS WITH EMPHASIS ON BITUMEN AND HEAVY OIL APPLICATION

Submitted to

CANMET

DEPARTMENT OF ENERGY, MINES & RESOURCES

By

THE TECHNICAL DEVELOPMENT DEPARTMENT

THE SNC GROUP

MONTREAL

219 pp

March 1983

SNC Ref. 8832

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PART I

TECHNICAL PROPOSAL

1.0 OBJECTIVES AND SCOPE OF THE WORK

1.0 OBJECTIVES AND SCOPE OF THE WORK

The objective of the work outlined in this proposal is to carry out an authoritative review and critical assessment of the methods which could be used.

- To improve recovery of bitumen or heavy oil from wellhead production fluids arising from commercial in in-situ thermal recovery projects.

- To scavenge oil and otherwise improve the quality of the water from in-situ thermal recovery projects for reuse (i.e. steam generation) or disposal.

The scope of this study includes the collection of all information concerning separation of oil/water/mineral emulsions or tailings and the review and selection of the commercial and emerging methods which can be used for such separations.

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The selected commercial and emerging methods will be assessed technically and economically. Selected commercial methods will be tested by the suppliers or developers of the systems. Emerging methods will be surveyed and ranked. Selected emerging methods will be further investigated experimentally. Those found to be possessing potential will be recommended for in-depth study and a proposal to carry out the additional work will be prepared. Based on the technical and economical data, recommendations will be made concerning the application of the most promising methods in treatment and separation of various emulsions and tailings.

2.0 LEGEND

2.0 LEGEND

ROI - Return on Investment

3.0 SUMMARY

3.0 SUMMARY

The aim of this study is to select the most effective methods for separating oil/water/minerals, stable emulsions which occur in the secondary recovery of petroleum or tar sand bitumin.

Information will be gathered by literature survey and contacts with developers, users and individuals to determine the following:

- Types of emulsions and their characteristics, i.e. the chemical compositions, the sources and the stability.
- Background information on what methods have been used to break these emulsions and what the degree of success there has been.

All the information will be critically reviewed to evaluate all the methods. A set of criteria will be developed, in conjunction with the Scientific Authority appointed by EM&R, which will be used to judge and select the best methods. The criteria would include all factors affecting performance, degree of separation, ease of operation and service life under field conditions.

An in-depth technical and economic assessment will be carried out for those methods deemed to have technical merit. The performance data on selected commercial methods will be obtained in collaboration with the process developers and equipment suppliers. An economic assessment of all the commercial methods which were found to be acceptable will be prepared. This will include the capital cost, operating cost, energy cost and the ROI on the basis of a cost to treat a barrel of oil at various levels of production.

Newer methods for the separation of these emulsions which have not reached the commercial scale will be identified. A preliminary technical and commercial assessment will be made on these processes to ascertain if they might be competitive if they were developed commercially.

3.0 SUMMARY (cont'd)

If the preliminary assessment indicates that any of them might be of value in the field after commercial development, then a proposal outlining the work necessary to make a more detailed techno-economic assessment would be prepared.

The final report will indicate:

- what is the existing state-of-the-art;
- which commercial process and type of equipment is most suitable for the various types of emulsions;
- which emerging techniques show promise of becoming worthwhile processes and equipment for field use;
- recommendations for various aspects which require further research and development.

4.0 JUSTIFICATION

4.0 JUSTIFICATION

About one trillion barrels of tar sand and one billion barrels of heavy oil are two important energy sources in Canada. The major part of the recoverable portion will have to be obtained from in-situ methods.

Heavy oil or bitumen produced from in-situ flooding methods come to the surface in an emulsion state, containing water, oil, or bitumen and minerals. These emulsions cannot be sent directly to a refinery before destabilization of the emulsion and separation of the water and the minerals from the oil because it would create problems in storage and operations.

The tailing water produced during heavy oil or bitumen emulsion treatment contains suspended finely divided minerals, associated with organic compounds. The presence of these complex fine particles in effluent waters is environmentally by objectionable.

The separation of oil/water/mineral from tailings would result in:

- Recovery of hydrocarbon material as a valuable product. The amount is considerable in a large quantity of tailings.
- Obtaining clean water which can be used in steam generation or can be disposed of without hazard to environment.
- Reduction of the amount of sludges in ponds.
- Application of a new separation technique in other industries faced with clay sludge treatment problems. This would result in the emergence of new technologies.
- Improvement of oil and bitumen quality by a better phase separation.

5.0 BACKGROUND

5.0 BACKGROUND

Many physical, chemical, electrical and biological techniques are available commercially for the separation of oil and water from emulsions and for treatment of water effluents. Many of them have been used successfully in specific cases [1].

There are many emulsions which are difficult to break, especially those emulsions obtained in recovery of heavy oil or bitumen by in-situ methods. Demulsification of these emulsions cannot be achieved by the simple separation techniques because of the presence of surfactants which may be polymer or mineral particles.

In recent years, many different trials have been made using commercial methods to separate the water and minerals from emulsions produced in in-situ methods. A typical example is the treatment of recovered emulsion from Lloydminster heavy oil recovery by an in-situ process. The usual oil field treatments such as settling tanks, heat and chemicals have been used with various degrees of success. The application of a wash tank, using condensate, chemicals and heat, at 130°F followed by settling tanks was shown to be cheaper than a heater-treater ($0.33/bbl versus $0.45/bbl). The prolonged settling of this system had beneficial effect on solid removal and breaking of the emulsion [2].

The typical commercial methods used in the treatment of heavy oil or bitumen recovered by in-situ methods are:

- Separators with or without heating for unstable emulsions.
- Chemicals and pressurized heater-treaters with or without electro-technique (AC or DC current) for more stable emulsions.
- Dilution of the emulsion with low API gravity hydrocarbon and with chemicals and the use of a heater-treater for very stable emulsions.
- Evaporation - heating the feed upto 330°F and flashing.

5.0 BACKGROUND (cont'd)

In heavy oil or bitumen emulsions and tailings, solid particles (clay) are associated with organic compounds. In tar sand bitumen recovery by an in-situ process, the amount of these clay particles brought to the surface is reported to be considerably less than that produced by hot water extraction process [3]. These fine particles are so small that they can pass through any ordinary filter paper [4, 5 and 13]. They are coated with organic compounds (generally with the heavy end fractions of the heavy oil or bitumen or surfactants)[6]. Therefore, they are kept in suspension, in either the water or oil phase depending on their hydrophilic and hydrophobic character[13].

The addition of surfactants and polymers in oil or bitumen recovery often causes the formation of a complex clay-organic compound, resulting in a more stable system, which makes the separation of minerals difficult. Various approaches have been investigated on a laboratory scale in recent years for the separation of these organo-mineral complexes found in hot water extraction tar sand tailings. Factors such as pH, temperature and ionic strength which are effective in the absorption phenomenon have been considered. Some of these investigations which have been partially successful are given below:

- SO_2 and HCl are considered to be the most effective agents in increasing the settling rate of tailings sludge [7].
- Reduction of the extractable bitumen in tailings sludge by 40% when using a glass wool filter suggested that a part of bitumen remained with clay. Gel formation was observed when clay dispersed in water, in the presence of the extracted bitumen [8].
- Carbon dioxide promotes bitumen recovery from tailings [9, 12].
- Achievement of flocculation by treatment of tailings sludge with optimum concentration of Mg^{2+} and Ca^{2+} and addition of high molecular anionic polyacryamide [10].

5.0 BACKGROUND (cont'd)

- Destabilization of remaining aqueous phase after the removal of oliogenous phase [11].
- Promotion of the break-up of bitumen-mineral agglomeration with high bicarbonate concentration, releasing the bitumen to the surface froth and removal of calcium by increase of pH, but however, the treatment resulted in the stabilization of the system [12].
- High molecular polyacryamide in presence of calcium ion destabilized the organic-clay complex suspension in a system [14].

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6.0 APPROACH AND WORK STATEMENT

6.0 APPROACH AND WORK STATEMENT

6.1 Approach

Information related to the separation of oil/water/minerals from an emulsion or tailings stream will be gathered. Combined physio-chemical and electrical methods and those methods which may be used separately, especially in emerging methods, will be evaluated on the basis of the degree of separation. All the methods will be compared and evaluated taking into account all factors. Data will be tabulated and promising methods will be selected. Based on this information, process flow diagrams will be developed for the selected methods.

Preliminary comparison of the promising commercial methods will be carried out to facilitate the technical evaluation. Factors such as pretreatment procedure, type of chemicals and their dosage, operating conditions of the system including temperature pressure, optimum pH, the ratio of water to oil and degree of separation and equipment for treatment of emulsions and separation of phases will be considered. Similar investigation will be carried out for tailings. Environmental hazards will also be taken into consideration.

Systems including a combination of two or more techniques such as pretreatment, heaters, dilution, electrotechniques and evaporation will be evaluated if applicable to various types of stable emulsions. Factors such as types of chemicals, system pressure, separation time, number of steps will be separately studied and evaluated.

In emerging methods, the improvement of separation by application of a new or modified methods will be looked into. The results will be evaluated for use in possible modification of a commercial method with a view to obtain higher degree of separation.

6.1 Approach (cont'd)

Selected methods which will be assessed in-depth, technically and economically, will be examined by test, if necessary. Economic factors such as capital cost, operating cost, cost of treatment per barrel and ROI will also be considered.

The assessment will rank the methods. The most suitable methods will be recommended for use in separation of oil and water from mineral particles.

6.2 Work Statement

This study will be carried out in seven tasks as follows:

Task 1: Literature Survey

The aim is to gather comprehensive literature and other data related to the separation of oil/water/mineral from a heavy oil or bitumen emulsion produced in in-situ thermal process or related areas.

Information will be obtained through various available sources including library search, papers, technical reports, research reports, and governmental reports. In-house literature search will be supplemented by conducting a search of relevant literature data bases.

SNC maintains good engineering library under the direction of a full time professional librarian. The library subscribes to all the major computerized search systems. SNC, in addition, subscribes to Inter-Library Loan Schemes.

6.2 Work Statement (cont'd)

The Computer searches available to SNC are:

- CA SEARCH, 1967 - present, 5,720,000 records, biweekly updates (Chemical Abstracts Service, Columbus, OH). The CA SEARCH database contains bibliographic data, keyword phrases, and index entries for all documents covered by Chemical Abstracts Service. CA SEARCH is an expanded database which contains the basic bibliographic information appearing in the printed Chemical Abstracts. Index entries containing CA General Subject Headings from a controlled vocabulary and the CAS Registry Numbers, a unique number assigned to each specific chemical compound, appear complete with modifying phrases. Additional uncontrolled complete keyword index phrases and cross referenced CA General Subject Headings are also included. This merged database provides the user with many more access points to each covered citation and thus greatly increases the ease of searching for both broadly defined topics and specific compounds.

- ENVIROLINE, 1971 - present, 99,000 citations, monthly updates (Environment Information Center, Inc., New York, NY). ENVIROLINE, produced by the Environment Information Center, covers the world's environmental information. Its comprehensive, interdisciplinary approach provides indexing and abstracting coverage of more than 5,000 international primary and secondary source publications reporting on all aspects of the environment. Included are such fields as: management, technology, planning, law, political science, economics, geology, biology, and chemistry as they relate to environmental issues. Literature covered includes periodicals, government documents, industry reports, proceedings of meetings, newspaper articles, films and monographs. Also included are rulings from the Federal Register and patents from the Official Gazette.

6.2 Work Statement (cont'd)

- COMPENDEX, 1970 - present, 1,122,000 records, monthly updates (Engineering Information, Inc., New York, NY). The COMPENDEX database is the machine-readable version of the Engineering Index (Monthly/Annual), which provides abstracted information from the world's significant engineering and technological literature. The COMPENDEX database provides worldwide coverage of approximately 3500 journals, publications of engineering societies and organizations, papers from the proceedings of conferences, and selected government reports and books.

- POLLUTION ABSTRACTS, 1970 - present, 88,000 citations, bimonthly updates (Cambridge Scientific Abstracts, Bethesda, MD). POLLUTION ABSTRACTS is a leading resource for references to environmentally related literature on pollution, its sources, and its control. The following subjects are covered by the POLLUTION ABSTRACTS database: Air Pollution, Environmental Quality, Noise Pollution, Pesticides, Radiation, Solid Wastes, and Water Pollution.

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Task 1 would be carried out in the following steps:

1) Select the necessary keywords in collaboration with the Scientific Authority and institute the computerized search.

2) Examine the abstracts obtained and from them obtain copies of the relevant articles.

3) Examine all the references cited in those articles and obtain any further relevant articles.

4) Set up a keyword file for all the articles and references. If the file is large enough it will be programmed for a computer.

6.2 Work Statement (cont'd)

Task 2: Identification and Contact with Process Developers, Equipment Manufacturers and Users

This task will be carried out with the objective to supplement the published information from organizations and individuals who are involved in the separation of oil/water/minerals, directly or indirectly.

SNC has developed working relationships with all equipment manufacturers, universities and research bodies, and government agencies, oil companies, and other users.

Contacts will be made with the following to obtain the necessary information:

- Universities and Research Organizations
  Data and findings on recent research works and information on new methods which have been applied on laboratory scale for treatment of emulsions and tailings will be obtained. Information on the type of materials and factors affecting the separation and level of success will be included in the above information.

- Oil Companies

  Information on conditions of the emulsion formation, type of surfactant and polymer used in oil or bitumen recovery will be obtained. Arrangements will be made for a SNC representative to visit sites. Contact will be also made with:

  - oil companies involved in heavy oil and tar sand bitumen recovery in in-situ method for all inforamtion on the treating of emulsions and tailings at present;

6.2 Work Statement (cont'd)

- oil refineries in which heavy oil or bitumen are refined or upgraded;

- Equipment manufacturers

  Information related to the type of equipments which have been developed for separation of various phases, including detailed technical information, will be obtained.

- Emulsifiers manufacturers

  Information on the capability of these organizations to make demulsifiers which can neutralize the used emulsifiers in the oil or bitumen recovery will be obtained.

Task 3: Classification and Identification of Information

Information and data obtained from different sources will be classified in such a way that each type of data could be identified and compared. Data will be classified in the following order:

- Type of oil or bitumen
  - Low API
  - High API

- Factors affecting emulsion formation:
  - type of emulsifiers
  - dosage
  - mode of formation of heavy oil and tar sand bitumen emulsion

6.2 Work Statement (cont'd)

- Emulsions and tailings characteristics:
  - physical properties
  - chemical properties

- Commercial methods:
  - Thermal methods such as flash distillation and heater-treaters.
  - Mechanical methods such as filter packs and coalescers.
  - Physico-chemical methods including pretreatment with chemicals, followed by physical separation techniques.
  - Thermo-chemical methods such as pretreatment together with heating followed by physical separation techniques.
  - Dilution technique, using light hydrocarbons to lower viscosity and specific gravity of the organic phase followed by physical separation technique.
  - Electrical methods using electrostatic system or dual polarity treater.

- Emerging methods including:
  - basic research work on clay behaviour in oil/water system;
  - type of organic compounds being absorbed in clay surface;
  - type of methods being used in separation of clay surface;
  - type of equipments used in separation studies;
  - effect of chemical agents on separation of minerals for oil/water phase;
  - effect of surfactants and polymers on stabilization of emulsions;
  - comprehensive studies on recovery of oil and bitumen from tailings;

6.2 Work Statement (cont'd)

- Modifications in previous processes
- Other unclassified literatures.

Task 4: Review of the Methods

The aim of this task is to review the various commercial and emerging methods in relation to separation of oil/water/minerals from heavy oil and bitumen emulsions and tailings and identifying the most promising methods regarding their status and potential.

Various methods will be identified, evaluated and compared. Those which are promising will be selected using the following criteria.

Comparison of Commercial Methods

- Comparison of physico - chemical methods, in which chemicals such as acids, gases, electrolytes, coagulants and demulsifiers and other chemicals are used for pretreatment of heavy oil or bitumen emulsions and their tailings, followed by commercial physical methods. In these physical methods such as heating, settling, centrifuging or flotation, separation is based on difference between specific gravities, molecular size, and boiling points of continuous and dispersed phases. Degree of separation will be identified in each case where available.

- Comparison of electrical methods will be carried out considering the degree of success in different oil fields.

6.2 Work Statement (cont'd)

Comparison of Emerging Methods

Classified information on new ideas and new methods which are either being developed or are at laboratory scale will be compared and evaluated according to their effectiveness, as follows:

- Various approaches which have been used for the solution of the problems including new equipments (such as new coalescers and separating membranes)
- Basic research works including:
  - Chemical structure of clay, surfactants, polymers and petroleum or bitumen end fractions.
  - Effect of different chemicals in settlement rate, meeting the chemical interaction requirement for separation of phases
  - Effect of application of natural colloids in tailings treatment
  - Effect of high molecular weight polyelectrolytes in flocculation of suspended phases.

Influencing Factors

Factors which affect on the separation of suspended phase in emulsions and tailing both in commercial and emerging methods will be identified. Tables and curves will be prepared where necessary to facilitate evaluation. Those methods which are less promising will be rejected and the methods showing potential will be selected for in-depth study. Technical evaluation will be based on the following factors:

- feed and output
- equipment including mixers
- horizontal or vertical flow
- type of the oil or bitumen (low or high API)
- stability of the produced emulsion

6.2 Work Statement (cont'd)

- Temperature (using various forms of heating)
- Pressure of the system
- Type of chemicals and their dosage
- Time of separation
- Degree of separation
- The effect of chemicals on each of the separated phases and requirement of a further treatment.

Task 5: Assessment

The commercial and emerging methods selected in task 4 will be assessed on the basis of their reliability, controlability and their efficiency. In depth study will be carried out technically on selected methods. Those of selected methods, which are found to show greater technical potential promising will be further evaluated experimentally and economically. The results of evaluation will be compared and ranked according to their suitability for separation of oil/water/minerals from an emulsion or tailings. The following procedure will be used to carry out this task:

- Selected commercial and emerging methods will be compared, evaluated and judged, on the following criteria in descending order:
  - Acceptable degree of success
  - Simplicity of the methods
  - Compatibility

The following procedure will be carried out for the technical and economical assessment:

6.2 Work Statement (cont'd)

- The sample of stable emulsions of heavy oil or bitumen and tailings will be sent to the commercial manufacturers or developers of the applied methods for the separation of water/oil and minerals.
- Contacts have been made with equipment developers and manufacturers and a number of them have agreed to carry out the test and supply with all the data and information. Table 6.1 lists only a few of the developers and/or manufacturers of the commercial methods. Partial list of the manufacturers of the equipments who have agreed to cooperate with SNC is also given in Table 6.2.
- Detailed information on destabilization of the samples, including degree of separation, time, energy consumption, type of materials, the availability and cost of the materials and equipments and their maintenance cost will be obtained.
- Results will be used to select methods which are considered to be most suitable for a specific type of emulsion, effective in separation or improvement of the quality of separated phases. Selection of the methods will be based on the properties of the emulsions, including API of the oil or bitumen, degree of stability, water and oil ratio and mineral content in the emulsion.

The following technical and economical factors will be considered in the final selection:

Technical Factors

- degree of separation
- number of steps in operation
- time of separation
- safety, involving application of chemicals and their effect on human beings
- environmental aspects
- energy requirement
- improvement in separation
- space requirement

6.2 Work Statement (cont'd)

Economic Factors

- operating cost
- capital cost
- maintenance cost
- energy consumption
- cost of separation/bbl
- return on investment

Emerging Methods

All the emerging methods would be surveyed, identified and reviewed. Methods which are found to be satisfactory will be examined in detail and, if necessary, these will be investigated experimentally. Those methods which show potential will be recommended for in-depth study. A proposal for carrying out the work in-depth would be prepared.

Task 6: Report

During routine liaison, the form of the final report and data for inclusion will be agreed upon. A draft report will be prepared which will give the mandate for work done, description of work performed, conclusions and recommendations.

CANMET comments and recommendations will be recorded and the draft report revised accordingly. Six copies of the final report will be submitted to the scientific authority.

TABLE 6.1

PARTIAL LIST OF THE
DEVELOPERS OR SUPPLIERS OF THE SYSTEM FOR SEPARATION OF
OIL/WATER/MINERALS FROM IN IN-SITU
OIL OR BITUMEN RECOVERY EMULSIONS

NAME AND ADDRESS OF COMPANIES	METHOD, CAPABILITY AND FACILITIES
CE - NATCO Division of Combustion Engineering, Tulsa, Ok, 74101, P.O. Box 1710	- Methods are used all over the world. Some of the users of the methods in Canada are: Mobil, Husky and AMOCO oil companies. - Facilities for testing of a sample available utilizing mechanical coalescers and electrostatic methods, with one bbl sample.
HTI Technology 10847 South Pinter Ave. Santa Fe Spring, Ca. 90670	- Separation of oil and water from emulsions obtained in combustion in in-situ methods and is being used by Husky Oil Co. in Canada. - Test facilities for 1000 bbl of emulsion available, utilizing mechanical and heater treater methods.
Continental Engineering Huston, Texas	- Methods comprising all commercial techniques. One of the systems is being used by Syria Petroleum Co. - Facilities for testing of emulsions is available.
SIVALLS Tank Inc. Odessa, Texas 2200 E 2nd	- Separation systems including heater treater are being used in a number of states in U.S.A.
Production Equipment Service Inc., Lafayette La, 3810 Cameron	- Proprietory system called "Titrator", consists of heating devices, chemical treatment equipment, and separation. - Methods are in use in U.S.A.
LATOKA 4900 South Louis, Tulsa, Ok.	- Heater treater, chemical and separation system. - Methods are in use in Arinoco heavy oil recovery in U.S.A.

TABLE 6.2

PARTIAL LIST OF THE
MANUFACTURERS OF THE EQUIPMENTS FOR SEPARATION
OF OIL/WATER/MINERAL FROM AN EMULSION

NAME OF THE MANUFACTURERS	EQUIPMENT, CAPABILITY AND FACILITIES
Alfa - Laval Ltd.	- Centrifuges being used all over the world. - Prepared to test emulsions.
KHD Canada Inc. (HUMBOLDT WEDAG division)	- Supplying 3 phase contrifuge. These are in use at tar sands treatment plant at Fort McMurray. - Facilities are available for testing emulsions.
ARMSTRONG Jones Ltd.	- Manufacturer of Resin impregnated cellulose coalescers for use in separation of treated emulsions. - Facilities available for testing.
Denver Division of Joy Corp.	- Floatation system available for testing the separation of minerals from emulsions for a fluid of 50 CP @ 250°F.
SELAS Corp. of America	- Manufacturer of various types of coalescers. - Facilities are available for testing.
WIX Inc. The branch of Industrial Division FACET Interprise, Inc. P.O. Box 50096, Tulsa Ok. 74150 or 925 Brock Road South Pickering, Ont. L1W 2X9	- Manufacturer of dual mode gravity and coalescing separator system. - Facilities are available for testing.

7.0 PROJECT TEAM

7.0 PROJECT TEAM

The selected project team is presented below:

Project Manager	Z.A. Siddiqi
Senior Research Engineer	Dr. S. Levine
Consultants	Dr. A.W. Newmann Dr. D. Cooper
Research Engineers	S. Nikkhoo Dr. T. Quy Phung Quach
Economical Analyst	B. Webber
Support Staff	Dr. T. Adley

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BRIEF RESUME OF KEY PERSONNEL

This section highlights the qualifications of the nominees for the key positions. Detailed resumes are included in Appendix B. In the event that any of the nominees is unavailable, SNC will provide back-up personnel with equivalent capacities, as listed in the task force. The nominees are:

Z.A. Siddiqi would serve as project manager. He has a number of years of experience in various aspects of research, development and design of equipment, development of techniques and methods. He has recently directed and managed a number of research projects dealing with the assessment of technologies, processes, techniques and methods. As a project manager, he has been responsible for successful organization, planning, execution and control of all phases of these projects. Some of his relevant experiences are given below:

7.0 PROJECT TEAM (cont'd)

- Management of Research and Development projects for D.S.S. encompassing the review and assessment of processes and technologies.
- Directed studies which included the state-of-the-art review of technologies and survey of commercial process used in oil and gas industries.
- Currently managing a number of experimental and analytical studies for CANMET.

Dr. S. Levine has over 50 years of experience in all aspects of emulsion treatment. His major achievements have been in the field of theories of strong electrolytes, charged interfaces, polymer adsorption, light scattering from colloidal particles, electrokinetic phenomena, two phase flow in porous media and in convection-diffusion in suspension. He is known nationally in these fields. He has to his credit over one-hundred publications in these fields. His specific experience related to the project are:

- Extensive theoritical knowledge on the surface phenomena related to oil/water/mineral system.
- Research on fine particles interaction in the above system.
- Research on sedimentation equilibrium in colloidal suspensions.
- Stability and properties of hydrophobic colloidal solutions.

Dr. A.W. Newmann is one of the leading authorities in this field in Canada. He has published extensively in this field.

7.0 PROJECT TEAM (cont'd)

Some of his directly relevant experiences are:

- Many years of experience both with fundamental and applied aspects of surface and colloid science.

  - Very recently developed a method to measure liquid/liquid interfacial tensions from the shape of sessile and pendant drops. The technique is free of the difficulties of the spinning drop technique.

  - Development of novel strategies of determining the wettabilities of small particles, such as clay. These strategies depend on the quantitative interpretation of the interaction of the unknown particles with flat and smooth surfaces of known surface properties.

- Modelling of interactions in dispersed systems:

  - Developed quantitative thermodynamic models which describe the equilibrium of small particles at liquid/fluid interface. This analysis is crucial for the study of oil/water emulsions which are stabilized by small (clay (clay) particles.

  - Has worked extensively on the quantitation of the relation between surface thermodynamic free energy banances and van der Waals forces. The outcome of this work allows a direct use of the DLVO theory to describe stability and interactions in colloidal systems quantitatively.

7.0 PROJECT TEAM (cont'd)

Dr. D. Cooper possesses wide experience in emulsion coaliscence, microbially enhanced oil recovery and water pollution control. He has published a number of papers related to this study. His related experiences are:

- Directed and supervised contract research in the following areas:
  - microbially enhanced oil recovery
  - emulsion coalescence
  - biosurfactant production and characterization.
- Investigated the relevance of "HLB" to demulsification of a mixture of heavy oil/water and clay.

S. Nikkhoo has over 30 years of experience in oil industry. He has been actively involved in formulations and manufacturing of anionic cationic and clay bitumen emulsion in laboratory and at pilot scale for several years. He possesses experience in the application of emulsions, in water seepage control, adobe brick and road construction. He has acquired extensive experience in demulsification of the oil/water/mineral emulsions. In recent years, he has investigated demulsification methods. Some of his experience directly related to the project are:

- Testing and characterization of the oil/water/minerals emulsions.
- Determination of the effect of factors such as pH and temperature on the stability and viscosity of the emulsions.
- Determination of type, dosage and required conditions for emulsification of bitumens using different types of surfactants.
- Determination of the factors in demulsification of emulsions and application to produce specified formulations.

7.0 PROJECT TEAM (cont'd)

Dr. B. Webber has been involved in various aspects of economic analysis and planning. He possesses experience in engineering economics and assessments of various techniques, processes and methods. Some of his related experiences are given below:

- Assessment of alternative systems for converting wood waste in useful energy.
- Economic impact study of various transportation systems.
- Economic assessment of alternative processes.

8.0 SPECIFIC QUALIFICATIONS

8.0 SPECIFIC QUALIFICATIONS

The SNC Group

The SNC Group is the largest integrated employee-owned consulting engineering, procurement and construction company in Canada. Its professional staff specializes in diverse fields, such as mining, energy, power and utilities, environmental control, transportation, chemicals and petroleum, heavy oil and tar sand.

The Technical Development Department was established in 1979 utilizing this resource to undertake innovative work and research and development. Since the inception of the department, the work carried out under contract for government departments and industries in the private sector has been increasing on an average growth rate of 120% per annum. This does not include the work done for the SNC Group companies. This undoubtedly demonstrates our successful track record in carrying out contract research and development. We have received repeat contracts for research and development from most of the clients. In particular, the SNC Technical Development Department has carried out a number of major technical and economic assessment studies in various technologies in the recent past. Some of these are:

- Technical Assessment of Coal Liquefaction Processes for Canada (1979-81)

  This was a shared cost project undertaken with the Department of Energy, Mines and Resources to carry out a technical assessment of coal liquefaction processes under development throughout the world. The study involved collaboration with the various process developers. Samples of Canadian coals were evaluated in their experimental or pilot plant equipment.

8.0 SPECIFIC QUALIFICATIONS (cont'd)

- Saskatchewan Coal Liquefaction (1981-1982)

  This investigation was a techno-economic study carried out under a contract with SASKOIL - CANMET - Petro Canada.

  The study involved selection of the coal liquefaction process for Saskatchewan lignite from more than 20 processes being developed in the world.

- Ontario Lignite Liquefaction (1983-1984)

  This study is being carried out on behalf of Ontario Ministry of Energy and will be carried out in three phases. This study will assess the potential of direct liquefaction of Ontario lignite.

- Biomass (Wood) Liquefaction (1980-1982)

  This 1980 ENFOR project study investigated the state-of-the-art of various methods of the liquefaction of biomass by various means. The study involved the selection of the best process design and cost estimate of pilot and commercial plants.

- Biomass Update (1982-1983)

  Technical and economic assessment study was carried out for N.R.C. This study included the selection of the best method and cost estimate for a commercial plant.

8.0 SPECIAL QUALIFICATIONS (cont'd)

A few of the relevant studies recently undertaken in the field of heavy oil and tar sand are listed below:

- AFE Investigation VG32, study involced modification to oil treating station and preparation of cost estimates for Mobil Oil.
- Athabasca Tar Sands, gathering system study for Alberta environment.
- Emissions inventory for the Athabasca Oil Sands Area for AOSERP.
- SNC undertook an investigation into all atmospheric emissions - both natural and manmade - for the entire oil sands area. A computerized inventory system was developed to store and retrieve a mass of data. A feature of this system was the ease with which new data could be added to the inventory.
- Study - Heavy Oil upgrading for Department of Energy, Mines and Resources - Saskatchewan Government.

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A comprehensive study was completed comparing alternative processes for upgrading Lloydminster heavy oil. The study required that both capital and operating costs be developed for several combinations of alternatives. A linear program then chose the economic combination for each of the main upgrading processes.

- Terminal upgrading study for Gulf Oil.
- Solvent deasphalting for Syncrude Canada.

An engineering study on the prospects of integrating into the syncrude oil sands flow sheet was completed. The study included flow sheet yields, mass energy balances, utility consumptions, capital and operating costs, and economics.

8.0 SPECIAL QUALIFICATIONS (cont'd)

The Technical Development Department, with the expertise of the professional staff of the SNC Group and qualified specialists, will be able to provide the best research team for the study.

Availability of Equipment and Facilities

Besides the SNC-Technitrol laboratory facilities, a number of major developers have agreed to carry out necessary testing using their pilot plant facilities. The facilities include the use of heater treaters, mechanical coalescers and electrical systems together with suggested chemical treatment. The result of these tests will be directly applicable to separation of oil/water/minerals from an emulsion system.

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PART II

PRICE PROPOSAL

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1.0 PROJECT COST

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1.0 PROJECT COST

The total price for the project is $90,185. over a period of 8 months. The direct labour cost is $73,385. The estimated labour cost is obtained by multiplying the number of days required to complete each phase by typical salary of the employee concerned.

- The labour rates of each category of personnel is given in Table 1.1.
- The labour costs using the rate Task 1.1 is given in Table 1.2.
- The total price for performing the work is given in Table 1.3.

TABLE 1.1

SNC LABOUR RATES

Cost Items						
Personnel	Typical Annual Salary $	Hourly Rate $/h	Fringe Benefit and Overhead $/h	SNC Fee @ 8.75% $/h	Total Hourly Rate (2+3+4) $	Daily Rate $
Project Manager	55,000	28.00	31.36	5.19	64.55	516.40
Consultants	53,000	27.00	30.24	5.01	62.25	498.00
Senior Research Engineer	50,000	26.00	29.12	4.82	59.94	479.52
Research Engineer	38,000	19.00	21.28	3.52	43.80	350.40
Economic Analyst	50,000	26.00	29.12	4.82	59.94	479.52
Estimator/Planner	35,000	18.00	20.16	3.34	41.50	332.00
Technician/Draftperson	32,500	17.00	19.04	3.15	39.19	313.52
Secretarial/Clerical	18,000	9.00	10.08	1.67	20.75	166.00

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TABLE 1.2

SNC LABOUR COST

Project Personnel	Hourly Rate $	Man-hours hrs.	Man-days	Total Cost $
Project Manager	64.55	168	21	$10,844.40
Consultants	62.25	144	18	8,964.00
Senior Research Engineer	59.94	144	18	8,631.35
Economic Analyst	59.94	56	7	3,356.64
Research Engineer	43.80	528	66	23,126.40
Estimator/Planner	41.50	80	10	3,320.00
Technician/Draftman	39.19	200	25	7,838.00
Secretarial/Clerical	20.75	352	44	7,304.00
TOTAL		1,752	209	$73,384.79

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TABLE 1.3

ESTIMATED TOTAL COST FOR THE STUDY

Direct labour from SNC Group including fringe benefit and overheads (Table 1.2)	$73,385
Test (including consummable materials	10,000
Travelling	2,000
Printing and Reproduction	2,000
Communication	1,800
Library Computer Service	1,000
	$90,185

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2.0 PRICE CERTIFICATION

2.0 PRICE CERTIFICATION

SNC Price Certification

We hereby certify that labour rates quoted are based on cost computed in accordance with Costing Memorandum DSS 1031, a copy of which we have acknowledged and that the said rates do not contain an element of profit.

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Overhead & Fringe Benefits

The overhead used herein was developed in accordance with Costing Memorandum DSS 1031, and does not contain any charges disallowed under that costing memorandum, nor does it contain an element of profit.

The combined cost of overhead and fringe benefits is 112% of salaries in accordance with the recent agreement reached between SNC and DSS. SNC

Direct Material Charges

The direct material charges are our best estimates at present. Any taxes will be small and are included in the estimate. Provincial Taxes will be excluded.

Foreign Content

No foreign content is envisioned.

SNC Fee

A fee of 8.75% of SNC's cost is used and is identical to that recently agreed upon after negotiation with DSS (OSS79-00032/5, June 79 and OS079-00091/23, Aug. 79).

2.0 PRICE CERTIFICATION (cont'd)

Future Negotiations

All future negotiations arising from this approval will be conducted in accordance with the provisions of Costing Memorandum DSS 1031.

Contract Plan and Report

Figure 2.1 contains Contract Plan and Report from (DSS 9143-3 (4181) completed in accordance with the instruction given in the Request for Proposal.

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Supply and Services Canada | Approvisionnements et Services Canada

APPENDIX "A"

DSS File No. 15SQ.23440-2-Bitumen-X

DSS-MAS 9143-3 (4/81)

CONTRACT PLAN AND REPORT FORM – FORMULE DE PROJET DE CONTRAT ET DE RAPPORT

CONTRACT TITLE – TITRE DU CONTRAT: TREATMENT OF BITUMEN/OIL EMULSION AND EFFLUENT WATERS

CONTRACTOR – ENTREPRENEUR: SNC INC.

FILE NO. – N° DU DOSSIER

SERIAL NO. – N° DE SÉRIE

TASK DESCRIPTION / DESCRIPTION DE LA TÂCHE	TASK DURATION IN MONTHS – DURÉE DE LA TÂCHE EN MOIS												TASK COST – COÛT DE LA TÂCHE		
	1	2	3	4	5	6	7	8	9	10	11	12	PLANNED / PRÉVU À L'ORIGINE	ACTUAL / PRÉSENTEMENT	E.T.C. / À VENIR
1. Literature survey													7,720		
2. Contact with developers, users and research organizations													7,810		
3. Classification of information													6,120		
4. Review of the commercial and emerging methods													15,450		
5. Assessment													33,475		
6. Report													19,610		
PLANNED COST BY MONTH / COÛT PRÉVU POUR CHAQUE MOIS	9,580	10,382	11,321	11,121	11,987	11,875	12,419	11,500					PLAN 90,185		
ACT. / PRÉSENT. E.T.C. BY MONTH / PRÉVISION POUR CH. MOIS														ACTUAL / COÛTS RÉELS	E.T.C. / À VENIR

Bid Receiving / Réception des Offres

PART III

PROJECT MANAGEMENT

1.0 PROJECT ORGANIZATION

1.0 PROJECT ORGANIZATION

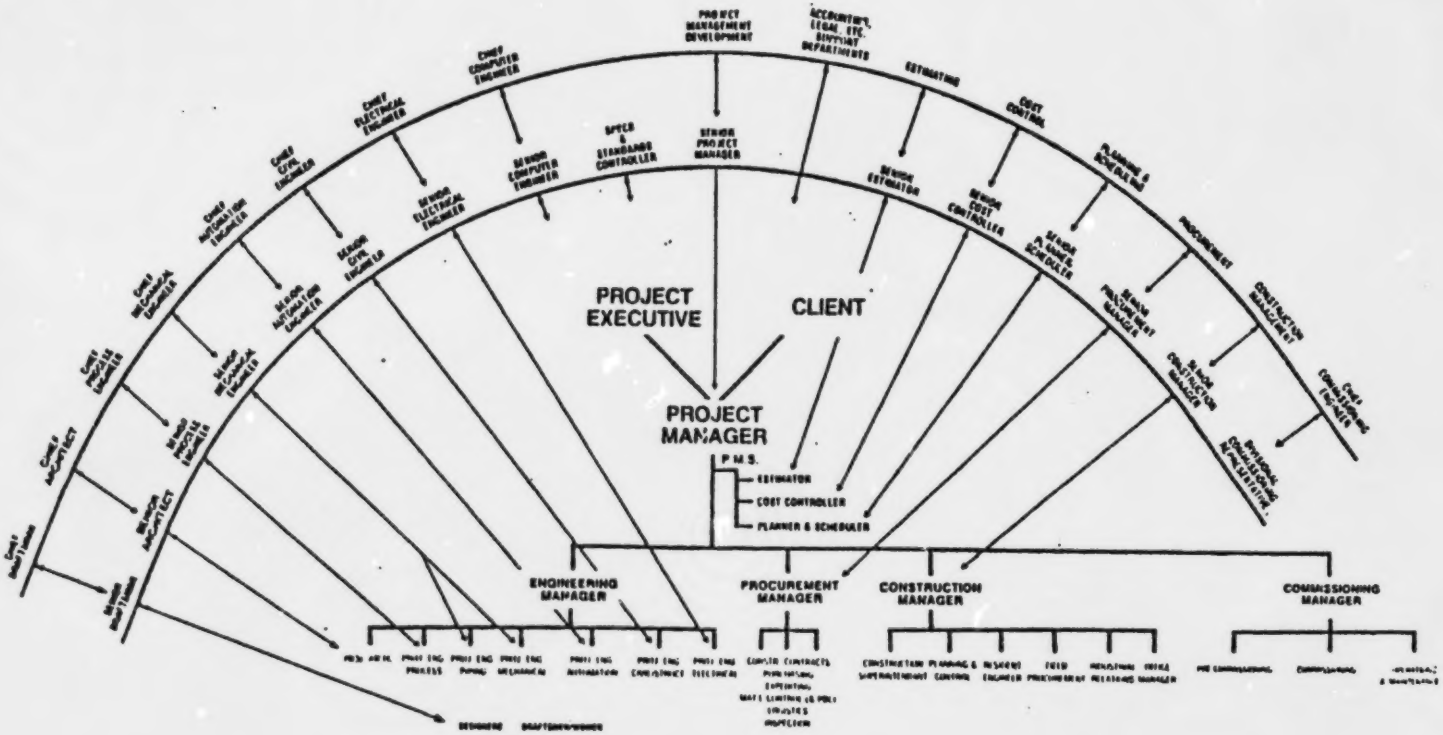
Project Task Force Concept

SNC is organized on a Project Task Force basis in which technical and project management provide support to the members of the task force (see Figure 1.1). For smaller projects, modified versions are implemented. All personnel assigned to your project task force will be physically located in one area of our offices. The organization chart proposed for your project is shown in Figure 1.2.

The most important member of the project task force is its leader - the Project Manager. He directs and controls the performance of a group of specialists whose individual skills are diverse but related. Due to the key role played by the Project Manager, special care has been taken in selecting the right individual to fill this position. Mr. Z.A. Siddiqi has been nominated to act as the Project Manager. Mr. Siddiqi is a well qualified, broadly-experienced engineer with a work history which includes research, development & design of equipment, development of techniques and methods for testing assessment of technologies, processes and methods and management of projects . He is responsible to both SNC and Client's Project Manager. He exercises authority and responsibility for the execution, financial and contractual aspects of the project. He is supported by specialists and a project management service team. Engineering Research Consultants have been selected for their in-depth experience in Research and Development and the design of similar facilities keeping in mind the complexity of the work. Their expertise has been derived from numerous prior jobs done and therefore would prove invaluable. They will be available on a continuous basis to offer expert advise on the technical problems as required.

SNC PROJECT ORGANIZATION CHART

& MANAGEMENT SUPPORT



PROJECT TASK FORCE

FIGURE 1.1

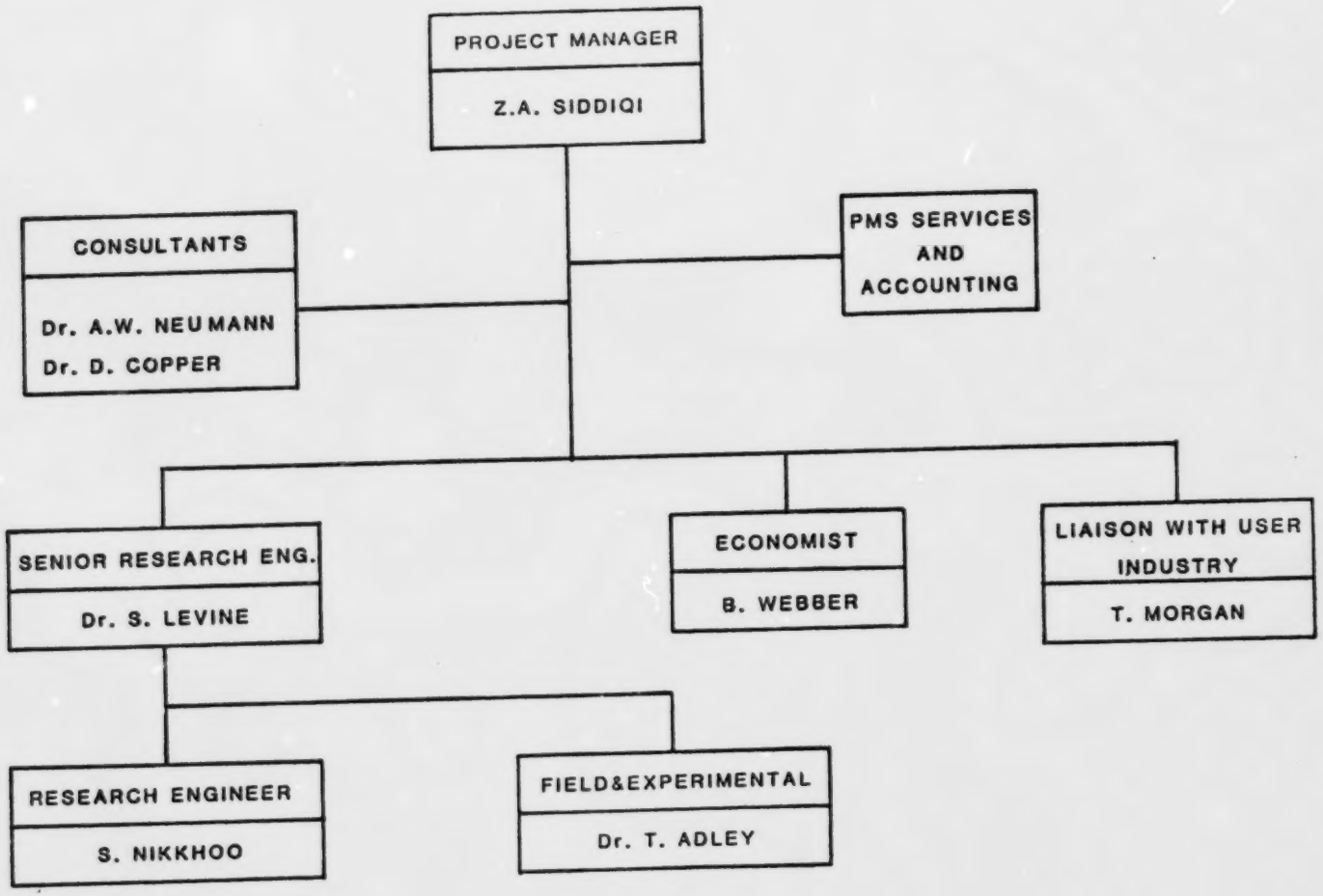


FIGURE 1.2 PROJECT ORGANIZATION

2.0 PROJECT EXECUTION CONTROL, MONITORING AND REPORTING

2.0 PROJECT EXECUTION CONTROL, MONITORING AND REPORTING

In this section, we outline our execution plan for this project. This is based on the specific requirements of the projects, and in particular, it takes into consideration the date of completion and priorities attached to various activities to accomplish this goal.

2.1 Review, Testing and Assessment

To ensure successful execution of this study, personnel with direct and relevant experience have been selected to work on this project. Major users, developers and manufacturers of the commercial methods and equipments have been contacted and agreed to undertake necessary testing for the assessment of the methods. Further, SNC possesses a well equiped laboratory to carry out tests to supplement the results obtained from the developers and undertake evaluation of emerging technologies. In addition, the project would be supported by personnels which have vast experience in the capital pilot plant estimate and economic assessment of necessary needs.

2.2 Planning, Scheduling, Monitoring and Controlling

Preparation of work break-down, showing the division of project into its physical elements and end items. Division of project into proposed "work packages" in the various suitable sections of preparation of preliminary definition of scope of each package.

Preparation of the Project Coding System, suitable for use in coding all SNC's activities, estimates, and for the numbering of drawings and other documents.

Preparation of the bar chart based on work break-down showing all activities and important milestones including:

- Design of the experimental facility and selection of equipment.
- Aquisition of the equipment and construction of the facility.
- Release of important information.
- Specification of safety and operating procedures.
- Testing of the facility.

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2.3 Monitoring and Control

After approval of the Schedule by the Clients, the Project Manager coordinates the efforts of the Project Task Force to ensure adherance to the plan.

Forecasted completion and man-days expended are accumulated to compare forecasted final costs against current budget, so as to ensure that project costs are controlled. Using the work break-down, each activity in the study will be assigned a man-day budget which will form the main cost control parameter for the study (see Figure 6.3 and Table 6.1).

Each cost item in the budget is coded according to our standard coding system which is then used to produce computerized cost reports for

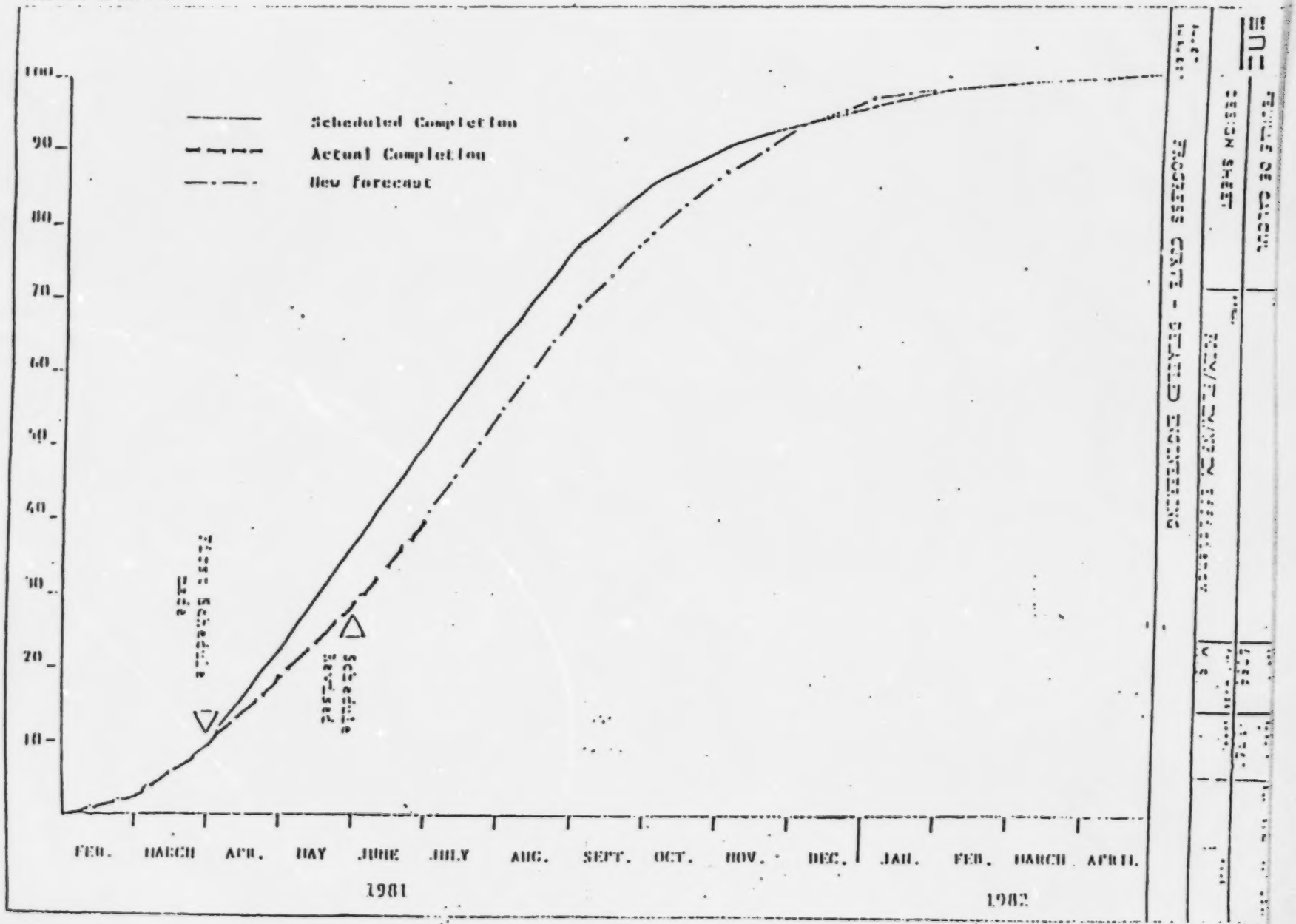
Scheduled Completion
Actual Completion
New forecast
100
90
80
70
60
50
40
30
20
10
FEB.
MARCH
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
JAN.
FEB.
MARCH
APRIL
1981
1982
PROGRESS CHART - STEAM GENERATING

TABLE 2-1

STIC	WORK AND EXPENDITURE CONTROL	CLIENT:	CONTR. 4086	SUBCONTR. 1741	CURRENT: Budget 0	Actual 0	DETAILED ENGINEERING
	MANHOUR PROGRESS	PROJECT: FCCU/FLUID/DIPTH EFFICIENCY	BC/UK				

DISCIPLINE	1 THIS MONTH	2 TO DATE	3 FORECAST TO COMP.	4 INDICATED TOTAL (2+3)	5 ORIGINAL BUDGET	6 APPROVED CHANGE NOTICES	7 CURRENT BUDGET (5+6)	8 PENDING CHANGE NOTICES	9 VARIANCE (4-7)	COMMENT
PROJECT MANAGEMENT	486	1934	4066	6000	6000	-	6000	-	-	Credit given to mechanical engineering from columns 5 & 6
PLANNING & SCHEDULING	261	865	1865	2730	2730	-	2730	-	-	
ESTIMATING	18	409	-	409	410	-	410	50	- 1	Change Notice No. 1
TRANSLATION	12	63	437	500	500	-	500	-	-	
CIVIL / STRUC.	1486	3096	6950	10046	10340	-	10540	333	+ 306	Change Notice No. 1
MECH./PIPING ENGINEERING	952	4466	3350	7816	7350	-	7350	200	+ 466	Change Notice No. 2 Change notice for 100 Hrs to be issued
MECH./PIPING DRAFTING	2758	10043	11114	21157	20960	-	20960	1212	+ 197	Change Notice No. 1
ELECTRICAL	392	1338	3665	5003	5000	-	5000	-	+ 3	
PROCESS	160	1394	756	2150	2500	-	2500	-	- 350	
AUTOMATION	900	2885	7255	10140	10425	-	10425	-	- 285	
CONSTRUCTION ENGINEERING	-	-	160	160	160	-	160	-	-	
TOTAL	7425	27293	39618	66911	66575	-	66575	1795	+ 336	

FOR PERCENT PROGRESS ... "PROGRESS BAR GRAPHS"

the manager's analysis. A bar chart schedule will be developed showing the time during which each specific task is to be performed. A preliminary bar chart schedule has been presented in this section. The schedule has an allowance built into it to accomodate possible delays in the receipt of information from diverse organizations.

Control over the project is exercised by the Project Manager in both informal and formal ways. The informal control arises due to the close proximity of the members of the study task force in performing the work and the close supervision with results.

Monitoring of all activities; monthly detailed review of progress; investigation of actual or potential deviations from schedule; initiation of corrective action to prevent or minimize effect of such deviations; revision of logis and/or updating of schedule as required; follow-up to ensure that planned remedial action is taken and is effective.

Preparation of monthly Progress Reports, showing status of all phases of the work, cost and commitments to date, forecast of final cost and other relevant information.

2.4 Project Code

The Project Code is developed at the earliest stage possible and is designed to cover the scope of the work to the fullest extent that is practicable, and updated to incorporated new items and changes of scope as they develop.

2.0 PROJECT EXECUTION CONTROL, MONITORING AND REPORTING (cont'd)

Project instructions are prepared to formalize communications and administrative details. They contain the scope of the work and the scope of the services, key plan, project master schedule, project organization, project directory, project coding for services, time charge coding and other special instructions.

2.5 Services Cost Control on Engineering

The Cost Control function is a continuous operation, beginning with the conceptual estimate, with estimating and monitoring procedures being applied during the design phase.

Time sheets approved by the Project Manager are submitted semi-monthly and computerized summaries are fed back to the responsible members of the Project Team.

Computerized service cost reports also are distributed semi-monthly to responsible member of the Project Team in the task group which is applicable to his responsibility and reviewed for variances and action.

3.0 PROJECT SCHEDULE AND MANHOURS ESTIMATE

3.0 PROJECT SCHEDULE AND MANHOURS ESTIMATE

3.1 Project Schedule

We have developed a conceptual schedule for the proposed project which is included in this section. An examination of the schedule in Figure 3.1 will show that the work will be carried out over a period of 8 months. The schedule illustrates the sequence of events and the time span covered for each activity.

3.2 Estimate of Manhours

We have carefully analyzed the scope outline included in Part I of our proposal and have estimated 1752 manhours. The break-down of manhours are given in Table 1.2 in Part II of this proposal.

Figure 3.1:

FOR

SEPARATION OF OIL/WATER/MINERAL STABLE EMULSIONS

Task No.	Task Description	MONTHS 1	2	3	4	5	6	7	8	Effort in ManHours
1	Literature survey	———	———	———	———					150
2	Contact with developers, users and research organizations		———	———	———					150
3	Classification of information		———	———						120
4	Review of the commercial and emerging methods			———	———	———				300
5	Assessment				———	———	———	———		650
6	Report							———	———	382

PART IV

METHOD OF PAYMENT

1.0 METHOD OF PAYMENT

Invoices shall be rendered monthly with sufficient support documentation to justify billings. Adjustments of any items which may be disputed will be made on the subsequent invoice and will not be a cause to delay payment of the invoice. Accounts are due within 30 days of the invoice date. Interest of two percent (2.0%) per month shall be charged on overdue accounts. All the liabilities arising from carrying out this work are covered by General Insurance Coverage.

We are prepared to accept a hold back of about 5% until we submit our final report.

APPENDIX A

REFERENCES

APPENDIX A

REFERENCES

1. Manual on Disposal of Refinery Wastes:, 1969

   - Chapter 8 - Treatment of Recovered Oil Emulsions
   - Chapter 9 - Filteration, Flocculation and Floatation
   - Chapter 10- Stripping, Extraction, Adsorption and Ion Exchange
   - Chapter 13- Biological Treatment

2. D.O. Gurel "Operating Practices to Improve the Profitability of Conventional Heavy Crude Production", Chapter 96, The Future of Heavy Crude and Tar Sands, First International Conference sponsored by the United Nations Institute for Training and Research (UNITAR) and AOSTRA and D.O.E. of the United States, June 4-12, 1979.

3. Clay Tailings from Alberta Oil Sands and Other Sources: A review, prepared by Alberta Research Council, Open File Report 1977-15, July 1977.

4. M.A. Kessick "Clay Slimes from the Extraction of Alberta Oil Sands, Florida Phosphate Matrix and other Mineral Deposits", CIM Bulletin pp 81, February 1978.

5. J.V. O'Gorman and J.A. Kitchener "The Flocculation and De-Watering of Kimberlite Clay Slimes" International Jourval of Mineral Processing, pp 34, 1 (1974).

6. David M. Clementz "Clay Stabilization in Sandstones Through Adsorption of Petroleum Heavy Ends" Journal of Petroleum Technology pp 1061, September 1977.

7. Martin B. Hocking and Graham W. Lee "Effect of Chemical Agents on Settling Rates of Sludges from Effluent of Hot-Water Extraction of Athabasca Oil Sands", Fuel, Vol. 56, 1977.

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9. E.S. Hall and E.L. Tollefson "Recovery of Residual Bitumen by Air Spraying from the Aqueous Tailings from Hot-Water Extraction of Oil Sands" Chapter 91, The Future of Heavy Crude and Tar Sands, First International Conference, sponsored by the UNITAR and AOSTRA, June 4-12, 1979.

10. S. Ramachandra RAO "Flocculation and Dewatering of Alberta Oil Sand Tailings", International Journal of Mineral Tailings, 245-253, 7 (1980).

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13. Polyelectrolytes for Water and Waste Water Treatment edited by William L.K. Schwoyer published by CRC, pp 92-93, 1981

14. Michael A. Kessick "Interaction of Polyacryamide with Heavy Oil Surfactants in the Presence of Calcium Ion" Fuel, Vol. 60, pp 1168, December 1981.

APPENDIX B

RESUMES

ZAFAR A. SIDDIQI, ENG.

Mr. Siddiqi has over 15 years' of experience with varying engineering and management responsibilities. His experience has ranged from design and development of products and systems to the complete management of engineer, procure and construct projects.

EDUCATION:

B.Sc., (Eng.), Mechanical Engineering, University of London, England

Post-graduate Diploma in Applied Mechanics, University of Sheffield, England

Barrister at Law, Inner Temple, London, England

M. Eng., Mechanical Engineering, Concordia University, Montréal, Québec, Canada

PROFESSIONAL ASSOCIATIONS:

Ordre des ingénieurs du Québec

EXPERIENCE:

Since 1973 — THE SNC GROUP - SURVEYER, NENNIGER & CHÊNEVERT INC., Montréal

Project Manager

- Management of EPC Projects. Responsible for organization, planning and execution of all phases of work: Feasibility Study, Estimate, Engineering, Procurement and Construction. Projects managed:
  - Carbon Dioxide Recovery Facilities for Liquid Carbonic Canada Ltd., at Pointe-Aux-Trembles, Québec, Canada
  - Modernization of Montréal Wharf Facilities at Montréal East Refinery for Shell Canada Ltd.
  - Sour Water Stripper Facilities, Syncrude Storage Facilities, Drainage System, Pipeway and Bridge, the Revamp of the Central Treating Plant, Flare System and Dock Shipping Pipeline Facilities for Imperial Oil Enterprises, at Montréal Refinery
  - Industrial Hygiene Building, Hypochlorite containment, Chlorate Scrubbing, the Expansion of the Sodium Chlorate Production Plant projects for Stanchem, at Beauharnois, Québec
  - Addition of C_3/C_4 Treating and Splitting System for B.P. Oil Ltd., at Montréal Refinery in Ville d'Anjou, Québec

- Expansion of the Ethylene Oxide/Glycol facilities for Union Carbide of Canada Ltd., Montréal, Québec.

Supervising Engineer
- Feasibility studies, process design, specifications, selection and procurement of centrifugal and reciprocating machines for Atomic Energy of Canada heavy water plants.
- Process design, specifications and equipment selection for Hercules Canada Ltd.'s 75,000 ton/year polypropylene plant in Varennes, Québec.

1970-72 ALLIS-CHALMERS CANADA LTD., Lachine, Québec, Canada

Project Engineer
- Design and development of turbo-machinery. Calculation of basic hydraulic and mechanical parameters for optimum design. Experimental testing of components and prototypes, and the application of test data to improve existing design and evolve new products.
- Responsible for the design and development of a series of centrifugal pumps for slurry applications with "Low Phi" characteristics, a new concept in pump design.

1968-70 UNITED AIRCRAFT OF CANADA LTD., Longueuil, Québec, Canada

Analytical Engineer
- Stress and heat transfer analysis of gas turbine components.

1966-68 HAYWARD TYLER & CO. LTD., Luton, England

Senior Development Engineer
- Engaged in the design and development of nuclear and conventional pressure vessels. Analytical design involved strength calculation, heat transfer, fluid flow, and application of pressure vessel codes. Experimental work entailed stress, temperature and flow measurements.

1964-66 CITY UNIVERSITY, London, England

Research Fellow
- Carried out independent research in theoretical and experimental structural analysis of frames and beamed structures.

1960-63 RUSTON & HORNSBY LTD., Lincoln, England

Research Engineer
- Basic design of diesel engines and gas turbines. Thermodynamics cycle calculation and structural analysis (stress and vibration) of the engines.
- Experimental simulation of design problems using analogue and photoelastic model techniques.

ZAFAR A. SIDDIQI, Eng. (cont'd)

1953-57 BRITISH ADMIRALTY, H.M. Dockyard, Devon Port, England

Engineering Cadet
- Marine engineering associated with operation and propulsion of Naval ships.
- Structure, hydrodynamics, stability associated with hull of ships.

LANGUAGES:

English
French (limited)
Urdu

CURRICULUM VITAE

Name: Samuel Levine

Present Rank: (Retired) Reader in Applied Mathematics, Senior Honorary Research Fellow, University of Manchester, England.
Visiting Scientist, Universities of British Columbia, Victoria and Guelph, Canada.
Consultant (visiting scientist), Oil Sands Research Department, Alberta Research Council, Edmonton, Alberta.
Retired from University of Manchester, Sept. 30, 1978.

Date and place of birth: February 15, 1911, Toronto, Ontario, Canada.

Citizenship: Canadian

Sex: Male Marital status: Married Children: 3

Education:

B.A., 1932, University of Toronto, 1st class honours in Mathematics and Physics

M.A., 1933, Ph.D., 1936, in Theoretical Physics, University of Toronto

D.Sc., 1967, University of Manchester, Manchester, England

Academic or professional awards and distinctions:

1928-32 - University of Toronto undergraduate scholarship

1930 - American Association for the Advancement of Science Award in Mathematics and Physics

1934-35 - Research fellowship in theoretical physics at the University of Cincinnati, Ohio, USA

1935-36 - John Frazer research fellowship in theoretical physics at University of Pennsylvania, USA - awarded Sigma Xi annual award in research

1936-37 - Post-doctorate grant in theoretical physical chemistry (American Association for Advancement of Science) under H. Eyring at Princeton University, New Jersey, USA)

1937-39 - Royal Society of Canada fellowship and D.S.I.R. grant held in Dept. of Colloid Science, Cambridge University, England under R.H. Fowler, J.E. Lennard-Jones and E.K. Rideal

Professional employment record:

1932-33 - Assistant demonstrator in physics, University of Toronto, Canada

1939-40 - Research associate in geophysics, University of Toronto, Canada

1942-44 - Instructor in physics, Princeton University, New Jersey, USA

1945-50 - Senior research associate in theoretical physics, Birkbeck College, University of London, England

1950-54 - Lecturer in applied mathematics, University of Manchester

1954-65 - Senior lecturer in applied mathematics, University of Manchester

1960 - Visiting scientist in Division of Applied Chemistry, National Research Council, Ottawa, Canada, for 10 months, leave of absence from University of Manchester

1962-64 - Summer research projects in colloids and light scattering in Department of Chemistry, Clarkson College of Technology, Potsdam, New York, USA

1965-78 - Reader in applied mathematics, University of Manchester

1966 - Summer research project, Department of Chemistry, Clarkson College of Technology, Potsdam, New York

1968 - Visiting professor during summer, Department of Chemistry and Centre of Theoretical Biology, State University of New York at Buffalo, Buffalo, New York, USA

1970-71 - Visiting scientist (on sabbatical) at Universities of California (Berkeley), Southern California (Los Angeles), British Columbia (Vancouver) and Victoria

1972-74 - Visiting scientist during summer, Departments of Chemistry
1975-78 (Victoria) and of Mineral Engineering and Chemical Engineering, British Columbia.

1974 - Leave of absence to Australia on lecture tour to Universities of Sydney, New South Wales, Melbourne, Adelaide, Perth and Australian National University - January-March

1974-75 - Nuffield visiting science lectureship at the Universities of Guelph, British Columbia and Victoria under sponsorship of the National Research Council of Canada

1978-82- Visiting scientist, Departments of Chemistry (Victoria and Guelph) and of Chemical Engineering (University of British Columbia).

1978-80- Consultant (visiting scientist) Syncrude Research Laboratory, Edmonton, Alberta (6 months of year).

1981- Special issue of Canadian Journal of Chemistry, (Volume 59, Number 3) in honour of my 70th birthday.

1982- Consultant (visiting scientist) Oil Sands Research Department, Alberta Research Council, Edmonton, Alberta (5 months of year).

1982 Research contract (3 months) with Division of Chemistry, National Research Council, Ottawa, Canada.

Areas of special interest and accomplishment in discipline:

Research Fields - Theories of strong electrolytes, electric double layer and colloid stability, charged interfaces, polymer adsorption, light scattering from colloidal particles, electrokinetic phenomena, two-phase flow in porous media, convection-diffusion in suspensions.

Publications

Problem of the sedimentation equilibrium in colloidal suspensions. Proc. Roy. Soc. (London) A 146, 597 (1934).

Statistical treatment of strong electrolytes. Proc. Roy. Soc. (London) A 152, 529 (1935).

Stability in hydrophobic colloidal solutions. Proc. Roy. Soc. London

(I) Interaction of two colloidal metallic particles - discussion and applications A 170, 145 (1939).

(II) Mathematical theory A 170, 165 (1939).

On the interaction of two colloidal particles using the complete Debye-Huckel equation. J. Chem. Phys. 7, 83 (1939).

Interaction between two hydrophobic colloidal particles, using the approximate Debye-Huckel theory (with G.P. Dube). Trans. Faraday Soc.

(I) General properties 35, 1125 (1939).
(II) Numerical computations of energy function 35, 1141 (1939).

Interaction energy of two hydrophobic sols. Application of the mutual energy of two particles (with G.P. Dube). Trans. Faraday Soc. 36, 215 (1940).

Stability properties in hydrophobic sols. Application of the mutual energy of two particles (with G.P. Dube). Trans. Faraday Soc. 36, 215 (1940).

On the mutual electrical energy of two colloidal particles. General theory using approximate Debye-Huckel equation (with G.P. Dube). Phil. Mag. (7) 29, 105 (1940).

General Discussion Colloid Stability. Trans. Faraday Soc. 36, 725 (1940).

Stability properties of hydrophobic colloidal solutions (with G.P. Dube). J. Phys. Chem. 46, 239 (1942).

On the calculation of gravity anomalies. Geophysics 6, 180 (1940).

On the interaction of colloidal particles

(I) Particular application to parallel plates. Trans. Faraday Society 42, B 102 (1946).
(II) Discussion of basis of theory. Trans. Faraday Society 44, 833 (1948).
(III) Some theorems concerning the free energy of double layers. Philosophical Magazine 41, 53 (1950).
(IV) General mathematical theory for two identical particles. Proc. Camb. Phil. Soc 47, 219 (1950).
(V) Nature of repulsion between particles in d lute sols. Proc. Camb. Phil. Soc. 47, 219 (1950).
(VI) Application of the Stern Theory of the double layer. J. Colloid Science 6, 1 (1951).

Simplified forms for free energy of the double layers of two plates in a symmetrical electrolyte (with A. Suddady). Proc. Phys. Soc. A64, 287 (1951).

Free energy of the double layers of two plates at large separations (with A. Suddady). Proc. Phys. Soc. A64, 431 (1951).

The free energy of the double layer of colloidal particles. Proc. Phys. Soc. A64, 781 (1951).

Free energy of the double layers of two parallel plates in a 1-2 electrolyte (with A. Suddady). Proc. Phys. Soc. A65, 405 (1952).

The free energy of the double layer of a colloidal particle and the charging process. Proc. Phys. Soc. A66, 357 (1953).

Interaction of two parallel plates using a modified Poisson-Boltzmann equation. Proc. Phys. Soc. A66, 365 (1953).

General Discussion. Discussion Faraday Society, coagulation and flocculation 18, 187, 202 (1954).

The interaction of two identical spherical colloidal particles (with N.E. Hoskin). Phil. Trans. Roy. Soc. London 248, 449 (1956).

General Discussion. Faraday Soc. Discussion - interaction in ionic solutions 24, 69, 73 (1957).

The specific interaction of two ions in a strong aqueous electrolyte (with H.E. Krigley). Faraday Society Discussions 24, 43 (1957).

Statistical thermodynamics of concentrated colloidal solutions (with G.M. Bell). Trans. Faraday Society.

(I) Free energy of electrical double layers, 53, 43 (1957)
(II) General theory of the double-layer forces on a colloidal particle, 54, 785 (1958).
(III) Some applications of the general for expression 54, 975 (1953).

Interaction of two parallel plates in a binary asymmetrical electrolyte I. univalent coagulating ion (with G.M. Bell). Can. J. Chem. 38, 1346 (1960).

Theory of a modified Poisson-Boltzmann equation I. The volume effect of hydrated ions (with G.M. Bell). J. Phys. Chem. 64, 1188 (1960).

Discreteness-of-charge effect and the stability theory of colloids (with G.M. Bell and D. Calvert). Nature 191, 699 (1961).

The interaction of two ions at small separations in an aqueous medium (with G.M. Bell). Triests Symposium, 1959, "Electrolytes" Pergamon Press (1962), pp. 77-95.

The discreteness-of-charge effect in electric double layer theory (with G.M. Bell and D. Calvert). Can. J. Chem. 40, 518 (1962).

The surface pressure of ionized monolayers (with G.M. Bell and B.A. Pethica). Trans. Far. Soc. 58, 904 (1962).

An extension to the stability theory of lyophobic colloids (with G.M. Bell). J. Colloid Science (October, 1962), 17, 838 (1962).

The discrete-ion effect in colloid theory (with G.M. Bell, J. Mingins and B.A. Pethica) presented at 36th National Colloid Symposium June (1972), Ottawa, Canada. J. Phys. Chem. 67, 2095 (1963).

The discrete-ion effect and colloid stability theory - two parallel plates in a symmetrical electrolyte (with G.M. Bell). J. Phys. Chem. 67, 1403 (1963).

Scattering of electromagnetic waves from two concentric spheres when outer shell has a variable refractive index (with M. Kerker) (Interdisciplinary Conference on Electromagnetic Scattering, Clarkson (1962), Potsdam, U.S.A., Pergamon Press, 37-46 (1963).

The ion exchange theory of coagulation (with E. Matijevic). Nature 197, 1196 (1963).

The interaction energy of an ion pair in an aqueous medium (with D.K. Rosenthal) - presented at 125th Meeting of Electrochemical Society, Toronto, 1964 - published in book form by Wiley and Sons in "Chemical Physics of Ionic Solutions" edited by B.E. Conway and R.G. Barradas, 1966, pp. 409-461.

A modified Poisson-Boltzmann equation in electric double layer theory (with G.M. Bell) - same as preceding paper.

Counter-ion penetration in ionized monolayers at a dialectric interface (with G.M. Bell and B.A. Pethica). J. Chem. Phys. 40, 2304 (1964).

The discrete-ion effect in the AgI system (with A.L. Smith, J. Mingin and G.M. Bell) - presented at IV International Congress on Surface Active Substances, Brussels, 1964 - published by Gordon and Breach, B11, 101 (1967).

The self-atmosphere of ions in surface phases (with J. Mingins and G.M. Bell) - same as preceding paper, B11, 89 (1967).

The discrete-ion effect and mutal antagonism in a hydrophobic sol containing a 1-1+2-2 electrolyte mixture (with G.M. Bell) - presented at 39th National Colloid Symposium, Potsdam, New York. J. Colloid Science, 20, 695 (1965).

The diffuse layer correction to the discrete-ion effect in electric double layer theory (with J. Mingins and G.M. Bell). Can. J. Chemistry 43, 2834 (1965).

Electromagnetic scattering by a spherically symmetric inhomogeneous particle (with G.O. Olaofe) - presented at 2nd Interdisciplinary Conference on electromagnetic scattering (1965) at Amherst, Mass., U.S.A. - published in book form by Gordon and Breach (edited by Rowell and Stein), pp. 237-292 (1967).

Discrete charges and condenser double layer models in colloid chemistry - a criticism. Kolloid Zeits. 205, 100 (1965).

Surface free energy and surface pressure of electrolytes and charge monolayers (with G.M. Bell) - Falkenhagen Commemoration. Zeits. phys. chem. 231, 289 (1966).

The cell and hexagonal lattice models for adsorbed ions in electrical double layer theory (with G.M. Bell and J. Mingins). Trans. Faraday Soc. 62, 949 (1966).

The discrete-ion effect in electric double layer theory (with J. Mingins and G.M. Bell) - presented at 20th International Congress on Pure and Applied Chemistry as a plenary lecture, Moscow, 1965. J. Electroanalytical Chemistry 13, 289 (1967).

The discrete-ion effect and surface pressures of ionized monolayers (with G.M. Bell and J. Mingins) - presented at 40th National Colloid Symposium, June 1966, at Madison, Wisconsin.

Correlation function in non-homogeneous charged regions (with G.M. Bell) - presented at I.U.P.A.P. meeting, Copenhagen 1966, pp. 258-274 in T.A. Bak, Statistical Mechanics, Benjamin 1967.

Modified Poisson Boltzmann equation and free energy of electrical double layers in hydrophobic colloids (with G.M. Bell). Disc. Faraday Soc. 42, 69, 1966.

Discussions Faraday Society, 42 contributions pp. 91-93, 95-98, 107-108, 140-142, 214-217 (1966).

Electrical forces between uncharged plates in ionic solutions (with G.M. Bell). Journal of Chemical Physics 49, 4584 (1968).

Discussions Faraday Society. The Structure and Properties of Liquids, Exeter, 1967. Contribution on hydrogen-bonding (with J.W. Perram) 43, 131 (1967).

A statistical mechanical treatment of hydrogen-bonding in water (with J.W. Perram), presented at Symposium on Hydrogen-bonding, Newcastle-upon-Tyne, January 1968 (published in book form by Taylor and Francis), ed. Covington and Jones, pp. 115-129 (1968).

Scattering of electromagnetic waves by two equal spherical particles (with G.O. Olaofe). J. Colloid and Interface Science 27, 442 (1968).

The interaction of two colloidal plates in a mixture of univalent and divalent ions. I. Large separation approximation (with J.E. Jones). Kolloid Zeits and Zeits fur Polymere 230, 306 (1969).

The interaction energy of an ion pair with overlapping hydration shells. A truncated spheres model (with D.K. Ross). Australian J. Physics 21, 571 (1968).

The Chi-potential at a solid surface in water-methanol mixtures (with A.L. Smith) - presented at IVth International Congress on Surface-Active Agents, Barcelona, September 1968 (published in book form), BII, 191.

Ionic components at the reversible AgI/aqueous electrolyte interface. J. Electroanalytical and Interfacial Chemistry 20, 403 (1969).

Kinetics of induced uphill transport of sugars in human erythrocytes (with M. Levine). Journal of Theoretical Biology 24, 85 (1969).

A comparison of the conditions of constant surface potential and constant surface charge in the D.L.V.O. theory of colloid stability (with J.E. Jones). J. Colloid and Interface Science 30, 241 (1969).

A theory of the electrical capacity of the inner region in the absence of ionic adsorption at the mercury/water interface (with G.M. Bell and A.L. Smith) - presented at the A.C.S. meeting Atlantic City, September 1968. J. Phys. Chem. 73, 3534 (1969)

An improvement on Derjaguin's Expression at small potentials for the double layer interaction energy of two spherical colloidal particles (with L.N. McCartney). J. Colloid and Interface Science 30, 3451 (1969).

A theory of adsorption from water-methanol mixtures on to a solid at the zero point of charge (with A.L. Smith and E. Matijevic) - presented at 43rd National Colloid Symposium, June 1969, Cleveland, U.S.A. J. Colloid and Interface Science, November 31, 409 (1969).

Recent theoretical work on the structure of water (with J.W. Perram) - presented at 157th National Meeting of Americal Chemical Society, Minneapolis, U.S.A., April 1969. Advances in Molecular Relaxation Processes 6, 85 (1974).

Light scattering by two spherical Rayleigh particles over all orientations (with A. Lips). J. Colloid and Interface Science 33, 455 (1970).

Approximate methods of determining the double-layer free energy of interaction between two charged colloidal spheres - presented at the A.C.S. meeting, New York, September 1969 (with G.M. bell and L.N. McCartney). J. Colloid and Interface Science 33, 335 (1970).

Some Consideration on the surface pressure of partially ionised monolayers (with G.M. Bell, B.A. Pethica and D. Stephens). J. Colloid and Interface Science 38, 609 (1972).

The effect of temperature on the competitive inhibition of sorbose transfer in human erythrocytes glucose (with M. Levine and M.N. Jones). Biochim. Biophys. Acta 225, 291 (1971).

Adsorption isotherms in the electric double layer and the discreteness-of-charge effects. J. Colloid and Interface Science 37, 619 (1971).

Theory of the differential capacity of the oxide/aqueous electrolyte interface (with A.L. Smith). Disc. Faraday Soc. 52, 290 (1971).

The surface pressure of ionized monolayers: A reply to Payens (with G.M. Bell, B.A. Pethica and D. Stephens). J. Colloid and Interface Science 33, 482 (1970).

Co-operative hydrogen bonding and the question of flickering clusters in water (with J.W. Perram). Molecular Physics 21, 701 (1971).

The effect of a diffuse layer in the solid phase at the silver iodide/aqueous electrolyte interface (with P.L. Levine and A.L. Smith). J. Colloid and Interface Science 34, 549 (1970).

The role of the diffuse layer in water-in-oil micro-emulsions (with K. Robinson). J. Phys. Chem. 76, 876 (1972).

The discreteness-of-charge effect at charged aqueous interfaces.

(I) General theory for single adsorbed ion species (with K. Robinson, G.M. Bell and J. Mingins). J. Electroanal. Chem. and Interfacial Electrochem. 38, 253 (1972).

(II) Single adsorbed ion species on mercury (with K. Robinson). J. Electroanal. Chem. and Interfacial Electrochem. 41, 159 (1973).

(III) Smoothly varying dielectric constant in inner region at mercury surface (with K. Robinson). J. Electroanal. Chem. and Interfacial Electrochem. 47, 295 (1973).

(IV) The self-image potential and its role in electrode kinetics (with K. Robinson and W.R. Fawcett). J. Electroanal. Chem. and Interfacial Electrochem. 54, 237 (1974).

Double layer interaction energy of a concentrated system of charged parallel colloidal plates in aqueous electrolyte (with C.S. Chen). Faraday Transactions II, 68, 1497 (1972).

The double-layer interaction of two charged colloidal spherical particles of a concentrated dispersion in a medium of low dielectric constant.

(I) Force calculations (with C.S. Chen). J. Colloid and Interface Science 43, 599 (1973).
(II) A cell model (with G.R. Feat). Faraday Transactions II, 71, 102 (1975).
(III) Approximation of perfectly conducting particles (with G.R. Feat) - presented at Amer. Chem. Soc. Meeting, Atlantic City, Sept. 9th, 1974. J. Colloid and Interface Science 54, 34 (1976).
(IV) Conducting particles in contact (with G.R. Feat). Faraday Transactions II, 72, 501 (1976).

The Esin-Markov effect. A test of electric double layer theory (with K. Robinson) VI International Congress on Surface Active Agent, Zurich, 1972 (Carl Hanser Verlag, Munchen) p. 615 (1973).

A theory pf electrophoresis of charged mercury drops in aqueous electrolyte solutions (with R.N. O'Brien). J. Colloid and Interface Science 43, 616 (1973).

Electric double layer properties of an oxide/aqueous solution interface, VI International Congress on Surface Active Agents, 1972 (with A.L. Smith and A.C. Brett), (Carl Hanser Verlag, Munchen) p. 603 (1973).

Discreteness-of-charge effects in electrode kinetics (with W.R. Fawcett). J. Electroanal. Chem. and Interfacial Electrochem. 43, 175 (1973).

The prediction of electrokinetic phenomena with multiparticle systems. I. Electrophoresis and electro-osmosis (with G.H. Neale) - presented at 47th National Colloid Symposium, Ottawa, Canada, 1973. J. Colloid and Interface Science 47, 520 (1974).

Site-binding model of the electrical double layer at the oxide/water interface (with D.E. Yates and T.W. Healy). Faraday Transactions I, 70, 1807 (1974).

Electrophoretic mobility of multiparticle systems (with G.H. Neale). J. Colloid and Interface Science 49, 330 (1974).

Theory of the electrokinetic flow in a narrow parallel-plate channel (with J.R. Marriott and K. Robinson). Faraday Transactions II, 71, 1 (1975).

Theory of electrokinetic flow in fine cylindrical capillaries at high zeta-potentials (with J.R. Marriott, G.H. Neale and N. Epstein) - presented at 48th National Colloid Symposium, Austin, Texas, 1974. J. Colloid and Interface Science 52, 136 (1975).

Theory of the rate of wetting of a porous medium, presented at 48th National Colloid Symposium, Austin, Texas, 1974. Faraday Transactions II, 71, 12 (1975).

Application of interferometry to the study of density gradients in emulsion creaming II. Some theoretical aspects (with R.N. O'Brien and A.I. Feher). J. Colloid and Interface Science 51, 310 (1975).

A mo... of the electric double layer at a completely ionized monolayer with dis...eteness-of-charge effect (with G.R. Feat) presented at N.K. Adam Memorial Symposium, Amer. Chem. Soc., Atlantic City, 1974. Advances in Chemistry Series 144, 98 (1975).

Dipolar effects in adsorption (with K. Robinson and A.L. Smith) - presented at Faraday General Discussions on Physical Adsorption in Condensed Phases, Bristol, April, 1975. Faraday Discussions 59, 133 (1975).

The conditions governing the specific adsorption of counter-ions in the interaction of two parallel plate-like colloidal particles (with G.M. Bell). J. Electroanal. Chemistry and Interfacial Electrochem. 65, 415 (1975).

Ion-size statistics and the Esin-Markov coefficient (with K. Robinson). J. Electroanal. Chemistry and Interfacial Electrochem. 58, 19 (1975).

The influence of ion-pairing at the electrode/solution interface on the kinetics of heterogeneous electron transfer (with W.R. Fawcett). J. Electroanal. Chem. and Interfacial Electrochem. 65, 505 (1975).

The electrostrictive effect in diffuse charged layers (with G.M. Bell). J. Colloid and Interface Science 56, 218 (1976).

The prediction of electrokinetic phenomena within multiparticle systems II. Sedimentation potential (with G. Neale and N. Epstein). J. Colloid and Interface Science 57, 424-437 (1976).

Fine particle deposition in laminar flow through parallel-plate and cylindrical channels (with B.D. Bowen and N. Epstein). J. Colloid and Interface Science 54, 375-390 (1976).

The double layer interaction of two charged colloidal spheres of a concentrated dispersion in a hydrocarbon medium (with G.R. Feat). Proc. Int. Conf. on Colloid and Surface Science (IUPAC), Budapest, Hungary, Sept. 1975, Vol. 1, 761-768 (ed. W. Wolfram).

A theory of the rate of wetting of a finely dispersed random porous medium (with G. Neale), S.C.I. Symposium on Wetting, Spreading and Adhesion, Loughborough, Sept. 1976, p. 241-260 (S.C.I. Monograph, Ed. J.F. Padday).

A theory of the rate of rise of a liquid in a capillary tube. Colloid and Interface Science, Vol. III, p. 403-419 (ed. M. Kerker, Academic press, 1976).

Ion-pair correlation functions in electric double layer theory. Colloid and Interface Science, Vol. IV, 15-28 (ed. M. Kerker, Academic Press, 1976).

Theoretical aspects of the rate of wetting of a proous medium (with G. Neale). Proc. Int. Conf. on Colloid and Surface Science (IUPAC), Budapest, Hungary, Sept. 1975, Vol. I, p. 768-717 (ed. W. Wolfram).

Ion-pair correlation functions in electric double layer theory (with G.R. Feat) Part 1 - Ions with the diffuse layer. Faraday Transactions II, 73, 1345-1358 (1977). Part 2 - Relevance to the discreteness-of-charge effect, Faraday Transactions II, 73, 1359-1370 (1977).

Some aspects of wetting/dewetting of a porous medium (with P. Reed, G. Shutts and G. Neale). Powder Technology 17, 163-181 (1977).

Theory of streaming at the polarographic maximum of the first kind (with H.B. Mead, R.N. O'Brien and A.C. Brett). J. Electroanal. Chem. and Interfacial Electrochem. 82, 227-249 (1977).

The Dorn effect in a concentrated suspension of spherical particles (with G. Neale and N. Epstein). Colloid and Interface Science Symposium, June 1977 (Monograph on Emulsions, Lattices and Dispersions, ed. P. Becher and M.N. Yudenfreud, Marcel Dekker) p. 289-303.

Non-Darcy flow and pressure distribution in a spouted bed (with N. Epstein). Engineering Foundation Conference on Fluidization, Cambridge, April 1978 (Monograph).

Streaming at the negative polarographic maximum of the first kind (with A.C. Brett and R.N. O'Brien). J. Electroanal. Chem. and Interfacial Electrochem. 89, 83-36 (1978).

Modes of polymer adsorption with excluded volume on parallel colloidal plates and their interaction (with M.M. Thomlinson and K. Robinson). Faraday Society Discussion on Colloid Stability, Lunteren, Netherlands, April, 1978, No 65, 202-214

A comparison of theories of the aqueous electric double layer at a charged plane interface (with C.W. Outhwaite). Faraday Transactions II, 74, 1670 1689 (1978).

Some aspects of discreteness-of-charge and ion-size effects for ions adsorbed at charged metal/aqueous electrolyte interfaces (with W.R. Fawcett). J. Electroanal. Chem. and Interfacial Electrochem. 99, 265-281 (1979).

Calculation of the mean electrostatic potential in the electric double layer in the mean spherical approximation (with C.W. Outhwaite and L.B. Bhuiyan). Chem. Phys. Letters 64, 150-153 (1979).

Numerical solution of a modified Poisson-Boltzmann equation in electric double layer theory (with L.B. Bhuiyan and C.W. Outhwaite). Chem. Phys. Letters, 66, 321-324 (1979).

A theory of capillary rise of a liquid in a vertical cylindrical tube and in a parallel-plate channel. Washburn equation modified to account for the meniscus with slippage at the contact line (with J. Lowndes and P. Reed). J. Colloid Interface Science 73, 136-151 (1980).

Theory of the electric double layer using a modified Poisson-Boltzmann equation (with C.W. Outhwaite and L.B. Bhuiyan) Faraday Transactions II, 76. 1388-1408 (1980).

A molecular model for the dielectric properties of the inner layer at the mercury-aqueous solution interface (with W.R. Fawcett, R.M. deNobriga and A.C. McDonald). J. Electroanal, Chem. and Interfacial Electrochem., 111, 163-180 (1980).

Two-phase fluid flow and hysteresis in a periodic capillary tube (with J. Lowndes and P. Reed). J. Colloid Interface Science, 77, 253-263 (1980).

Statistical mechanical theories of the electric double layer (with C.W. Outhwaite and L.B. Bhuiyan) - presented at Vth International Congress on Solute-Solute-Solvent Interactions, June 1980, Florence, Italy - J. Electroanal. Chem. and Interfacial Electrochemistry, 123, 105-119(1981)

Clay-bitumen interactions and their relevance to tar and processing (with E. Sanford) - preprint, presented at 30th Canadian Chem. Eng. Conference, October 1980, Edmonton

The Dorn effect in a concentrated suspension of spherical particles (with R. Ellwood, N. Epstein and G. Neale) - preprint, presented at 30th Canadian Chem. Eng. Conference, October 1980, Edmonton

Variation of the diffuse layer potential with surface charge in a modified Poisson-Boltzmann equation, (with C.W. Outhwaite and L.B. Bhuiyan). Chemical Physics Letters, 78, 413-415 (1981)

Numerical Solution of a modified Poiss on-Boltzmann equation for 1-2 and 2-1 electrolytes in the diffuse layer (with C.W. Outhwaite and L.B. Bh iyan) - Molecular Physics 42, 1271-1290 (1981)

Theory of electrokinetic behaviour of human erythrocytes (with M. Levine, K.A. Sharp and D.E. Brooks) - to appear in Biophysical Journal (1983).

A theory of electrophoresis of emulsion drops in aqueous two-phase polymer systems- presented at Material Research Society Annual Meeting, Boston (1981)- published in 'Materials Processing in the Reduced Gravity Environment' (ed. G. E. Rindone), 1982, North Holland, p. 241-248.

Application of percolation theory to capillary pressure-saturation effects in a porous medium (with D. E. Cuthiell and J. Lowndes)- presented at 55th Colloid and Surface Science Symposium, Cleveland, June (1981)- submitted to Amer. Inst. Chem. Eng. J. and under revision.

Relative permeabilities in two-phase flow through porous medium- presented at 28th I U P A C Congress, Vancouver, August (1981).

A theoretical model of trickle-bed electrodes used in eletrosynthesis of alkaline peroxide solutions (with C. Oloman,U.B.C.)- presented at 161st Meeting, Electrochemical Society, Montreal, May 1982-published as Volume Proceedings, Electrochemical Process and Plant Design, ed. R. Varjian, 1983.

Diffusion coefficients for gases in liquids by the constant size bubble method I. Demonstration that coefficient is overestimated (with R.N.O'Brien and A. Langlais)- presented at 28th Congress, Vancouver, August (1981).

A model of the inner region containing adsorbed ions and solvent dipoles (with W. R. Fawcett)- presented at 161st Meeting, Electrochemical Society, Montreal, May 1982.

Theory of spherical agglomeration and its application to bitumen recovery from oil sands- Report to Division of Chemistry, National Research Council, Ottawaunder contract serial number OSX82-0005- to be presented at 57th Colloid and Surface Science Symposium, Toronto, June, 1983.

The sedimentation of mine tailings in a marine environment, Report to Institute of Ocean Studies, Sidney, British Columbia, under contract ISB81-00483.

Stabilisation of emulsion droplet s by fine powders (with E.Sanford, Syncrude Research)-submitted to Can. J. Chem. Eng. and under revision.

An equation for the liquid-vapour interface near the three-phase (liquid-solid-vapour) contact region at equilibrium- (with L. B. Bhuiyan)-presented at Annual C.I.C. Conference,Toronto,1982.

CURRICULUM VITAE

Department of Mechanical Engineering

Date: June 7, 1982

Revised date:

SECTION 1: PERSONAL INFORMATION

1.1 Name AUGUST WILHELM NEUMANN

1.2 Date of Birth December 3, 1933

1.3 Education

Degree	Institution	Department	Thesis Field	Year
B.A.	U. of Toronto	Physics		1959
Ph.D.	U. of Mainz, Germany	Chem. Physics	Surface Thermodynamics	1962
Habilitation	U of Stuttgart, Germany		Physical Chemistry of Surfaces	1972

1.4 Full Time Employment, Sabbatical Leave and University Administrative Functions i.e. Chairman, Associate Dean, Graduate Co-ordinator, etc.

Dates	Employer	Position
1962-69	Fraunhofer-Gesellschaft, Inst. Phys. and Chem. of Interfaces, Stuttgart, Germany	Research Scientist
1969-70	State University of New York at Buffalo, Department of Chemical Engineering	National Science Foundation (U.S.), Senior Foreign Scientist
1970-71	State University of New York at Buffalo, Departments of Chemical Engineering and Engineering Science	Visiting Associate Professor
1971-73	University of Toronto, Department of Mechanical Engineering	Associate Professor
1973-present	University of Toronto, Department of Mechanical Engineering	Professor
1977-78	Sabbatical Leave: Department of Chemistry, University of München, München, Germany	Visiting Professor

1.5 Lifetime Academic, Research and Professional Honours (prizes, medals, honorary fellowships, etc.)

Date	Award Title	Awarded By	Terms of Award
1969	Senior Foreign Scientist Fellowship	National Science Foundation (USA)	Awarded to senior foreign scientists with outstanding record of performance; each U.S. university may apply for one every second year; about half the applications are granted.

SECTION 2: PROFESSIONAL ACTIVITIES

2.1 Professional Association Activities
(e.g., APEO Examinations Board, Chairman Papers Review Committee CANCAM)

Date	Association	Capacity
April, 1976	ACS	Organizer and Chairman, 1976 Kendall Award Symposium, held in New York City
June, 1977	ACS (American Chemical Society)	Chairman, Symposium on Contact Angles, held as part of the 51st Colloid and Interface Science Symposium, Buffalo, N.Y.
1977-80	ACS	Organizer of Symposia dealing with Surface Thermodynamics (jointly with R.J. Good, Buffalo, N.Y., U.S.A.)
August, 1980	ACS	Chairman and Organizer, Symposium on Repulsive van der Waals Interactions, Las Vegas, Nevada
June, 1983	ACS	Chairman and Organizer of the 57th Colloid and Surface Science Symposium, ACS Division of Colloid and Surface Chemistry, in Toronto. The conference comprises nine symposia with presumably over 200 papers

2.2 Technical Consulting and Advisory Activities
(Also list consulting company involvement)

Duration	Client	Activity
1972-present	Hospital of Sick Children, Toronto	Research and development of biomaterials and biomedical devices. Official position in HSC: "Consultant"
1974-present	University Space Research Association - NASA	Member of USRA Committee "Surface Science under Microgravity Conditions"
1975-76	NASA	Member of NASA task force to establish space processing designs for shuttle
1979-present	General Foods, Tarrytown, N.Y., USA	Consulting for physical chemistry, dentistry groups in the company's corporate research center
1981-present	General Foods, Canada Ltd., Cobourg, Ontario	Consulting on range of problems, including Image Analysis; design of equipment
1981-present	General Motors, Manufacturing Development, Warren, Mich., USA	Surface Thermodynamics of Adhesive Bonds
1982	Bendix - Advanced Technologies, Columbia, Md, USA	Consulting on fiber reinforced plastics for the company's corporate research center.
		A variety of refereeing assignments, including refereeing of approximately 20 manuscripts annually for journals with a refereeing system, including J. Phys. Chem., J. Colloid Interface Sci., Colloids and Surfaces, J. Biomed. Materials Res., BIOMATERIALS, CIRCULATION RESEARCH. Refereeing grant applications for NSERC, MRC and the Banting Research Foundation. Member, editorial board of BIOMATERIALS

2.3 Professional Interests
(Identify major areas of interests)

The activities of my group may be described as "Applied Surface Thermodynamics". These efforts may be divided into three main groups.

1. Fundamental Aspects of Applied Surface Thermodynamics
2. Applications to Energy Resources Processing
3. Applications to Biomedical and Biotechnological Problems.

1. Fundamental Aspects of Applied Surface Thermodynamics.

   Many of the tools which are needed to deal with the problems under 2 and 3 do not exist, and therefore have or had to be generated. Examples are techniques to measure the surface tension of solids, methods to determine contact angles on powders, or a proper thermodynamic description of capillary systems with high curvature.

2. Applications to Energy Resources Processing.

   Our novel approaches to the determination of contact angles on small particles are applied to studies of coal: separation of coal from gangue material, production of coal oil mixtures, analysis of changes of surface properties of coal due to aging or pretreatment.

   Similarly, surface characteristics of oil sand systems are determined. It is expected that understanding and being able to manipulate surface properties in such systems will be of value in designing or improving processes for the separation of the bitumen from the sand and clay residue.

3. Applications to Biomedical and Biotechnological Problems.

   We pursue the possibilities of understanding biomedical and biotechnological processes from a thermodynamic point of view. One of the benefits of such an approach is the fact that it allows one to distinguish between specificity and non-specificity in the biomedical sense. Novel, efficient procedures for separation and isolation of biological cells and proteins evolved, and significant insight was gained into the mechanisms of phagocytosis and thrombus formation elicited by vascular inplants. Study of some of the reasons for the peculiar behaviour of cancer cells is now a possibility.

2.4 Scholarly Addresses and Conference Presentations

This list is incomplete at this time. It contains some addresses from 1970-76. It is complete from 1978 - Present.

1. "Effect of Temperature and of Phase Transitions on Contact Angles", Gordon Conference on Chemistry at Interfaces, (invited), New Hampshire, 1970.

2. "Characterization of Solid Surfaces and Their Phase Transitions by Measurements of Contact Angles and Their Temperature Dependence", Gordon Conference on Adhesion, (invited), New Hampshire, 1970.

3. "Thermodynamic Status of Contact Angles", Gordon Conference on Adhesion, (invited), New Hampshire, 1971.

4. "The Surface Thermodynamics of Phagocytosis", The American Chemical Society, New York, 1972.

5. "Characterization of Polymer Surfaces by Measurements of the Temperature - Dependence of Contact Angles and Surface Tensions", The American Chemical Society, Dallas, 1973.

6. "Surface Thermodynamics and Biomedical Applications", Department of Materials Science, University of Utah, Salt Lake City, 1973.

7. "Surface Thermodynamics and Biomedical Applications", Czechoslovak Academy of Sciences, Prague, 1973.

8. "Thermodynamics of Platelet Adhesion", Toronto Biomaterials Society, 1974.

9. "Cellular Interfacial Free Energies, Cell Adhesion, Phagocytosis and Thrombogenicity", American Institute of Chemical Engineers, Pittsburgh, 1974.

10. "Surface Techniques to Detect Conformation Changes in Polymers", The Gordon Research Conference on Polymer Physics, (invited), New Hampshire, 1974.

11. "Thermodynamics of the Interface between Biomaterials and Blood", 13th Annual Conference of Metallurgists, Toronto, 1974.

12. "A Thermodynamic Approach to Platelet Adhesion", 5th Canadian Medical and Biological Engineering Conference, Montreal, 1974.

13. "Thermodynamics of Contact Angles", Chemistry and Materials Division, Atomic Energy of Canada Limited, Chalk River, 1974.

14. "Thermodynamic Aspects of Cellular Interfacial Phenomena", Dunlop Medal Award Symposium, 58th Canadian Chemical Conference, Toronto, 1975.

2.4 Scholarly Addresses and Conference Presentations cont'd

15. "Phagocytosis and Interfacial Free Energies", Gordon Conference on Chemistry at Interfaces, (invited), New Hampshire, 1975.

16. "Contact Angle Studies and Platelet Interactions with Various Surfaces of the Same Gels", Polymer Division of the American Chemical Society, Chicago, 1975.

17. "Thermodynamic Aspects of Particle Engulfment by Solidification Fronts", University Space Research Association, Lehigh Unversity, Bethehem, Pa., 1975.

18. "Die Rolle der Oberflächenspannung in Zweiphasenströmungen", Institut für Hydromechanik, University of Karlsruhe, Germany, 1976.

19. "Thermodynamic Aspects of Particle Engulfment and Rejection by Solidifying Melts", Joint Seminar of the Departments of Chemical Engineering and Chemistry and the Institute of Colloid and Surface Science, Clarkson College, Potsdam, N.Y., 1976.

20. "The Thermodynamics of Platelet Adhesion", 71st Scientific Meeting of the British Engineering Society, Keele University, England, September 1978.

21. "The Influence of Extremely Small Attractive as Well as Repulsive van der Waals Forces on Cell Interactions", American Chemical Soc., Miami, Florida, November, 1978.

22. "Thermodynamics of Biological Cell Adhesion to Polymer Surfaces", Adhesion Society, Savannah, GA, February 1979.

23. "Thermodynamic Studies of Cell Adhesion", Clinical Research Society, Toronto, March 1979.

24. "Complete Dissociation of Antigen-Antibody Complexes by Means of Repulsive van der Waals Forces", Federation of Biological Societies, Dallas, Texas, April 1979.

25. "Thermodynamic Studies of Cellular Adhesion", American Society for Artificial Internal Organs, New York, N.Y., April 1979.

26. "Determination of Contact Angles and Interfacial Tensions from Particle Engulfing Experiments", American Chemical Society/Chemical Society of Japan Chemical Congress, Honolulu, Hawaii, April 1979.

27. The Antigen-Antibody Complex and Erythrocyte Destruction: Physico-Chemical Considerations", 11th Annual Scientific Symposium, American Red Cross (Immunobiology of Erythrocytes), Washington, DC, May 1979.

28. "Repulsive van der Waals Interactions in Liquids", 53rd Colloid and Surface Science Symposium, Rolla, MO, June 1979.

2.4 Scholarly Addresses and Conference Presentations cont'd

29. "Interfacial Tension and Critical Closing Phenomenon in the Microcirculation", Symposium on Microcirculation, La Holla, California, June 1979.

30. "Thermodynamics of Cellular Adhesion", 3rd Intern. Conference on Surface and Colloid Science, Stockholm, Sweden, August 1979.

31. "Free Energy Analysis of Heterogeneous Cylindrical Particles at Fluid Interfaces", Semi-Annual Meeting of the American Chemical Society, Washington, D.C., September 1979.

32. "Reactions at Interfaces and the Determination of Surface Tensions", Seminar to the Dept. of Biochemical Engineering, University of Western Ontario, London, Ontario, November 1979.

33. "Surface Thermodynamics of Leukoycyte and Platelet Adhesion to Polymer Surfaces", Poster Presentation, 1st World Biomaterials Congress, Baden, Austria, April 1980.

34. "Elution of Human Granulocytes from Nylon Fibres by Means of Repulsive van der Waals Forces: A Preferable Alternative to Filtration Leukapheresis", Clin. Res. Soc., Toronto, April 1980.

35. "Elution of Blood Group Antibodies from Human Erythrocytes", Clin. Res. Soc., Toronto, April 1980.

36. "Thermodynamics of Bacterial Engulfment by Bacteria", Clin. Res. Soc., Toronto, April 1980.

37. "Surface Tension of Fixed Human Erythrocytes", Clin. Res. Soc., Toronto, April 1980.

38. "Thermodynamics of Platelet Adhesion", Seminar to Department of Biophysics, University of Western Ontario, London, Ontario, May 1980.

39. "Determination of Solid/Melt Interfacial Tensions and of Contact Angles of Small Particles from the Critical Velocity of Engulfing", 54th Colloid and Surface Sci. Symposium, Lehigh University, Bethlehem, Pa., U.S.A., June 1980.

40. "Interfacial Tensions and van der Waals Interactions of Small Particles at Solid/Liquid Interfaces", 54th Colloid and Surface Sci. Symposium, Lehigh University, Bethlehem, Pa., U.S.A., June 1980.

41. "Dimensional Analysis of the Behaviour of Small Particles at Solidification Fronts", 54th Colloid and Surface Sci. Symposium, Lehigh University, Bethlehem, Pa., U.S.A., June 1980.

42. "Contact Angle Measurements on Coal Particles from Freezing Front Experiments", 54th Colloid and Surface Sci., Symposium, Lehigh University, Bethlehem, Pa., U.S.A., June 1980.

2.4 Scholarly Addresses and Conference Presentations cont'd

43. "Surface Tension and Wettability Studies of Human Erythrocytes Using the Freezing Front Technique", 54th Colloid and Surface Sci. Symposium, Lehigh University, Bethlehem, Pa., U.S.A., June 1980.

44. "Capillary Condensation and the Generalized Theory of Capillarity", 54th Colloid and Surface Sci. Symposium, Lehigh University, Bethlehem, Pa., U.S.A., June 1980.

45. "The 'Hydrophobic Effect': Essentially a van der Waals Interaction", 54th Colloid and Surface Sci., Symposium, Lehigh University, Bethlehem, Pa., U.S.A., June 1980.

46. "Thermodynamics of Particle Interactions with Solidification Fronts", Seminar for Dept. Metallurgy and Materials Science, U. of Toronto, July 1980.

47. "Negative Hamaker Coefficients and Repulsive van der Waals Interactions in Liquids", 180th ACS Meeting, Las Vegas, August 1980.

48. "Determination of Surface Tensions of Proteins. I. Surface Tensions of Native Serum Proteins in Aqueous Media", 180th ACS Meeting, Las Vegas, August 1980.

49. "Limitations and Generalizations of the Classical Theory of Capillarity", 180th ACS Meeting, Las Vegas, August 1980.

50. "Determination of Surface Tensions of Proteins. II. Surface Tension of Serum Albumin, Altered at the Air Interface", 180th ACS Meeting, Las Vegas, August 1980.

51. "Elution of Granulocytes from Nylon Fibres by means of Repulsive van der Waals Forces", 180th ACS Meeting, Las Vegas, August 1980.

52. "Effects of Zero van der Waals and Zero Electrostatic Forces on Droplet Sedimentation", 180th ACS Meeting, Las Vegas, August 1980.

53. "Platelet Adhesion to Smooth and Rough Surfaces under Static and Dynamic Flow Conditions", 1st Canadian Biomaterials Society Meeting, Montreal, August 1980.

54. "Surface Tension and Wettability Studies on Glutaraldehyde - Fixed Human Erythrocytes", Canadian Medical and Biological Engineering Society, 8th Annual Meeting, Hamilton, Canada, August 1980.

55. "Interfacial Forces as a Possible Factor Involved in the Critical Closing Phenomenon", Canadian Biological Engineering Society, 8th Annual Meeting, Hamilton, Canada, August 1980.

56. "Contact Angle Measurements on Coal Particles from Solidification Front Experiments", 19th Annual Conference of CIMM, Halifax, N.S., Canada, August 1980.

2.4 Scholarly Addresses and Conference Presentations cont'd

57. "Dissociation and Characterization of Circulating Immune Complexes by Means of Repulsive van der Waals Forces", Canadian Cardiovascular Soc. Annual Meeting, Winnipeg, October 1980.

58. "Platelet Adhesion to Smooth and Rough Biocompatible Surfaces under Static and Flow Conditions. Implications for Cardiovascular Research", Canadian Cardiovascular Soc. Ann. Mtg., Winnipeg, October 1980.

59. "Platelet Phagocytosis of Bacteria", 1980 Joint Meeting of the American and Canadian Physiology Soc., Toronto, Canada, October 1980.

60. "Elution of Intact Human Granulocytes from Nylon Fibres by Means of Repulsive van der Waals Forces", American Association Blood Banking, Washington, D.C., November 1980.

61. "Elution of Blood Group Antibodies and Recovery of Intact Eluted Erythrocytes or Granulocytes", American Assoc. Blood Banking, Washington, D.C., November 1980.

62. "Thermodynamics of the Interaction of Biological Cells with Solid-Liquid Interfaces", Seminar for Dept. Chem. Eng., U. of Toronto, Novermber 1980.

63. "Determination of Interfacial Tensions and Contact Angles on Small Particles from Freezing Front Experiments", Seminar for Dept. Chem. Eng., Case Western Reserve University, Cleveland, Ohio, January 1981.

64. "Cell and Protein Adhesion to Synthetic Surfaces", 4th Annual Meeting of Adhesion Society, Savannah, GA, February 1981.

65. "Dependence of the Stability of Erythrocyte Suspension Layers on Particle Interaction Forces", 181st National Am. Chem. Soc. Meeting, Div. of Colloid & Surface Chemistry, Atlanta, Georgia, April 1981.

66. "A Novel Technique for the Characterization of Surface Properties of Coal Powders", 181st National Am. Chem. Soc. Meeting, Div. of Analytical Chemistry, Atlanta, Georgia, April 1981.

67. "Dependence of Sample Suspension Broadening on Fixed Erythrocyte Concentrations in Stationary and Flowing Systems", 2nd International Meeting of Electrophoresis Soc., Charleston, S.C., April 1981.

68. "Polyacrylamide gels as Candidate Biomaterials", Clinical Research Soc., Toronto, Canada, May 1981.

69. "Platelet Adhesion to Smooth and Rough Surfaces: in vitro and ex vivo Studies", 7th Annual Meeting of the U.S. Society for Biomaterials, Troy, N.Y., May 1981.

2.4 Scholarly Addresses and Conference Presentations cont'd

70. "Repulsive van der Waals Forces in Dispersed Systems", Invited Plenary Lecture, 55th Colloid & Surface Science Symposium, Cleveland, Ohio, June 1981.

71. "Specific Heats of Coal Powders by Differential Scanning Calorimetry", 55th Colloid and Surface Sci. Symposium, Cleveland, Ohio, June 1981.

72. "Friction Experiments: the role of van der Waals Interactions in Solid-Liquid-Solid Systems", 55th Colloid and Surface Sci. Symposium, Cleveland, Ohio, June 1981.

73. "On the Curvature Dependence of Surface Tension", 55th Colloid and Surface Sci. Symposium, Cleveland, Ohio, June 1981.

74. "Recent Progress in the Freezing Front Technique for Surface Tension Measurements", 55th Colloid and Surface Sci. Symposium, Cleveland, Ohio, June 1981.

75. "Rate Dependent Contact Angle Measurements on Smooth and Rough Surfaces", 55th Colloid and Surface Sci, Symposium, Cleveland, Ohio, June 1981.

76. "Role of Attractive and Repulsive van der Waals Forces in Affinity and Hydrophobic Chromatography", 4th International Meeting on Affinity Chromatography, Nijmegen, The Netherlands, June 1981.

77. "Surface Tension of Blood as Determined by Contact Angle Measurements", 2nd Annual Meeting of Canadian Biomaterials Society, Hamilton, Canada, June 1981.

78. "Determination of the Surface Tension of Human Blood Cells and Absorbed Serum Proteins in an Aqueous Medium", 2nd Annual Meeting of Canadian Biomaterials Society, Hamilton, June 1981.

79. "Surface Thermodynamics of Particle Interaction with Solidification Fronts", Seminar for Regional Research Laboratory, Trivandrum, India, July 1981.

80. "Surface Phenomena in Biological Processes", Series of Five Lectures for Sree Chitra Tirmual Medical Centre, Trivandrum, India, July 1981.

81. "Platelet Phagocytosis as a Model for Platelet Adhesion", 8th International Thrombosis Haemostasis Meeting, Toronto, July 1981.

82. "Surface Tension and Adhesion of Biological Cells and Proteins", 4th International Conference on surface & Colloid Science, Jerusalem, July 1981.

83. "Repulsive van der Waals Interactions and Their Possible Role in Detergency", 4th International Conference on Surface & Colloid Science, Jerusalem, July 1981.

2.4 Scholarly Addresses and Conference Presentations cont'd

84. "Approaches to the Determination of Contact Angles and Surface Tensions of Polymers", Invited Introductory Lecture, International Symposium on Physicochemcial Aspects of Polymer Surfaces, N.Y. City, August 1981.

85. "Novel Techniques to Determine Surface Tensions and Contact Angles of Biological Cells and Proteins", 182nd Am. Chem. Soc. Mtg., Division of Colloid and Surface Chemistry, New York, N.Y., August 1981.

86. "Platelet Phagocytosis as a Model for the Study of Forces Involved in Platelet Adhesion", 2nd European Conference on Biomaterials, Göteboerg, Sweden, August 1981.

87. "Interaction of Solid Particles with a Plane Substrate in a Liquid Medium. Experimental Evidence of Repulsive van der Waals Forces", 34th International Meeting of the Société de Chimie Physique, Paris, France, September 1981.

88. "Modulation of Attractive and Repulsive Electrostatic and van der Waals Forces in Preparative Separation Methods", 11th N.E. Regional Mtg. A.C.S., Rochester, N.Y., October 1981.

89. "Abstossende van der Waals - Kräfte und ihre Beziehung zur Grenzflächen-thermodynamik, Bestimmung, Anwendung und Problematik", invited plenary lecture, 30th General Meeting, Kolloid-Gesellschaft, Ulm Germany, October 1981.

90. "Methods of Measuring Surface Tensions of Cells and Biopolymers", Implications for their interactions, Life Science 1981, November 1981.

91. "Interaction of Small Particles with Solidification Fronts", Seminar for the Department of Chemical Engineering, Charkson College of Technology, Potsdam, N.Y., January 1982.

92. "Erythrocyte Adhesion to Polymer Surfaces: Influence of Electrical Charges", 183rd ACS Meeting, Las Vegas, Nevada, April 1982.

93. "Surface Thermodynamics of Bacterial Adhesion", 183rd ACS Meeting, Las Vegas, Nevada, April 1982.

94. "Image Analysis in Biology", Canadian Microscopical Association", Toronto, Ontario, April 1982.

95. "Platelet Phagocytosis as a Model for Platelet Adhesion", Am. Soc. Artif. Intern. Organs, Chicago, Illinois, April 1982.

96. "Determination of Surface Tensions and Contact Angles from the Shape of Axiscymmetric Interfaces", American Oil Chemists' Society Meeting, Toronto, May 1982.

2.4 Scholarly Addresses and Conference Presentations cont'd

97. "Repulsive van der Waals Interactions and Their Possible Application in Technological Processes", American Oil Chemists' Society Mtg., Toronto, Canada, May 1982.

98. "Dependence of Suspension Stability on Particle Interaction Forces", American Oil Chemists' Society Mtg., Toronto, Canada, May 1982.

99. "The Effect of Particle Shape on Particle Engulfment by Solidification Fronts", American Oil Chemists' Society Mtg., Toronto, Canada, May 1982.

100. "The Testing of Surface Tension Theories", American Oil Chemists' Society Mtg., Toronto, Canada, May 1982.

101. "The Use of Image Analysis for the Quantification of the Size Distribution of Disperse Systems", American Oil Chemists' Society Mtg., Toronto, Canada, May 1982.

102. "Surface Tension of Bitumen Extracted from Oil Sands", American Oil Chemists' Society Meeting, Toronto, May 1982.

103. "Novel Strategies and Techniques for the Study of Interactions in Dispersed Systems", Seminar for Division of Chemistry, NRC, Ottawa, May 1982.

104. "The Effect of Storage on the Surface Tension of Coal Powders", 56th Colloid and Surface Science Symposium, Blacksburg, VA, June 1982.

105. "A Novel Approach to the Determination of Very Low Liquid-Liquid Interfacial Tensions from the Shapes of Axisymmetric Menisci", International Symposium on Surfactants in Solution, Lund, Sweden, June 1982.

106. "Specific Heats of Coal Powders by Differential Scanning Colorimetry", The Colorimetry Conference, Snowbird, Utah, July 1982.

2.5 Research Grants/Contracts/and Equipment Grants

Duration	Grantor	Type	Co-grantees	Topic	Amount
1971-73	NRC	Operating		Allotropic Phase Changes	$ 30,000
1972-73	NIH	Contract	W. Zingg, C.A. Ward	Thromboresistant Biomaterials	$ 65,000
1973	NRC	Equipment		Applied Surface Thermodynamics	$ 67,000
1974-77	NRC	Operating		Applied Surface Thermodynamics	$ 66,000
1974-77	Con-naught	Grant	M.A. Mos-carello	Conformational Changes of Proteins	$160,000
1975-77	MRC	Operating	W. Zingg	Thermodynamics of Platelet Adhesion	$ 36,000
1977-78	MRC	Operating	W. Zingg	Thermodynamics of Platelet Adhesion	$ 22,000
1977-80	NRC	Operating		Applied Surface Thermodynamics	$101,000
1978-80	MRC	Operating	W. Zingg	Thermodynamics of Adhesion	$ 70,000
1979	NATO	Travel		Contact Angles	$ 4,000
1979	Bickell Found-ation	Research		Establishment of a Small Surface and Colloid Chemistry Facility within the Laboratory for Surface Thermodynamics	$ 6,000
1979-80	EMR-CANMET	Contract		Contact Angle Measurements on Irregularly Shaped Solid Particles	$ 39,470
1980	NSERC	Equipment		Image Analysis	$197,000
1980-81	AOSTRA	Contract		Determination of Surface Thermodynamic Parameters of Tar Sand Systems	$ 46,274
1980-81	EMR-CANMET	Contract		Contact Angle Measurements on Irregularly Shaped Solid Particles	$ 74,976

2.5 Research Grants/Contracts/and Equipment Grants cont'd

Duration	Grantor	Type	Co-grantees	Topic	Amount
1980-83	NSERC	Operating		Applied Surface Thermodynamics	$121,000
1980-83	MRC	Operating	W. Zingg	Thermodynamics of Cell Adhesion	$173,500
1981	NSERC	Strategic Equipment		Image Analysis	$111,000
1981-82	EMR-CANMET	Contract		Contact Angle Measurements on Irregularly Shaped Solid Particles - Phase III	$ 85,171
1981-82	AOSTRA	Contract		Parameters of Tar Sand Systems	$ 43,837
1981-82	Employment & Immigration Canada	Personnel Grant			$ 12,000
1981-82	PASC	Research		Research in Applied Surface Thermodynamics	$ 5,100
1982	BILD	Equipment		Parameters of Tar Sand Systems	$ 47,800
1982-83	EMR-CANMET	Contract		Development of Techniques to Study Surface Properties Relevant to Coal Processing and Oil Recovery	$ 95,447

2.6 Graduate Students

(Completed and current Graduate Student supervision. For current supervision, indicate starting date in date column with asterisk)

Date	Degree	Candidate	Thesis Title
1971	Ph.D.	J.D. Eick	Surface Roughness: Its Influence on Wetting and Adhesion and its Importance for a Dental Adhesive
1972	M.S.	P.K. Basu	The Temperature Dependence of the Surface Tension of Solutions of Atactic Polystyrene
1973	M.Eng.	N. Natarajan	Environmental Effects on High Surface Energy Solids
1974	M.Eng.	S.W. Yang	Surface Effect on Dropwise Condensation
1975	M.Eng.	P. Rosenberg	Phagocytosis as a Surface Phenomenon: The Effect of Mucin on Phagocytosis
1975	M.A.Sc.	S.N. Omenyi	Engulfment of Particles by Solidifying Melts
1975	M.A.Sc.	Y. Harnoy	The Temperature Dependence of Contact Angles on Polyethylene Terephthalate
1975	M.A.Sc.	L. Boruvka	An Extension to the Classical Theory of Capillarity
1976	M.A.Sc.	A.V. Rapacchietta	Force and Free Energy Analysis of Cylindrical and Spherical Particles at Fluid Interfaces
1976	M.A.Sc.	A. Hameed	Dropwise Condensation of Steam The Effects of Surface Phenomena
1977	M.A.Sc.	M. Hogan	A Feasibility Study of the Use of the Wilhelmy Technique to Study Possible Electrically Induced Conformational Changes in Proteins
1977	M.A.Sc.	O. Economopoulos	Free Energy and Force Analyses of Heterogeneous Cylindrical Particles at Fluid Interfaces
1978	M.A.Sc.	D.W. Francis	Temperature Dependent Contact Angle Measurements
1978	Ph.D.	S.N. Omenyi	Attraction and Repulsion of Particles by Solidifying Melts
1978	M.S.	H.N. Shiffman	A Preliminary Investigation of Principles Relating to Biological Cell Separation Using Solidifying Melts of Aqueous Solutions (Inst. Biomed. Eng., Dept. of Physics, co-supervised with W. Zingg)

2.6 Graduate Students cont'd
(Completed and current Graduate Student supervision. For current supervision, indicate starting date in date column with asterisk)

Date	Degree	Candidate	Thesis Title
*1978	Ph.D.	D.W. Francis	Particle-Liquid-Solid Interactions
1979	M.A.Sc.	J.K. Spelt	Surface Tension Measurements of Biological Cells Using the Freezing Front Technique
1979	M.A.Sc.	Y. Rotenberg	Dropwise Condensation: An Experimental Study of the Effects of Surface Characteristics (jointly with A.H. Abdelmessih)
*1979	Ph.D.	Y. Rotenberg	Surface Thermodynamics of Curved Liquid Surfaces
1980	M.A.Sc.	M.R. Soulard	Contact Angle Measurements on Coal Particles from Freezing Front Experiments
*1980	M.A.Sc.	I. Tsim	The Effect of Aging and Drying on the Surface Tension of Coal
1981	M.A.Sc.	R.P. Smith	The Development of a Technique to Determine Interfacial Tensions from Particle Behaviour at a Solid-Liquid Melt Interface
*1981	M.A.Sc.	Z.M. Potoczny	Interfacial Properties of Tar Sand Systems
*1981	M.A.Sc.	S. Li	Wettability Studies of Carbon Fibres
*1981	Ph.D.	R.P. Smith	The Freezing Front Technique as a Tool
*1981	Ph.D.	J.K. Spelt	Testing Competing Theories in Surface Science
1982	M.A.Sc.	J.B. Cain	Dynamic Contact Angles and the Effect of Roughness
*1982	M.A.Sc.	D.H. Lee	Applications of the Freezing Front Technique

2.7 Post Doctoral Supervisor and Contract Employees Supported by Research Contracts

Duration	Fellow	Financial Sponsor	Topic of Study
1972-73	M. Herbert, Ph.D.	NIH	Thromboresistant biomaterials
1972-73	C.J. Hope Ph.D.	NIH	Thromboresistant biomaterials
1974-76	S.K. Chang Ph.D.	Connaught Fund	Thromboresistant biomaterials
1974-78	O. Hum	MRC	Cell Adhesion
1975-76	C. Deber, Ph.D.	Connaught Fund	Thromboresistant biomaterials
1976-78	P. Chang	MRC	Cell Adhesion
1978-	Z. Policova	MRC	Cell Adhesion
1978-	E.I. Vargha-Butler, Ph.D.	EMR/AOSTRA	Coal and Oil Sands
1980-	D.R. Absolom, Ph.D.	Image Analysis	Image Analysis
1980-81	J. Chappuis, Ph.D.	NSERC	Tribology
1981-	T. Zubovits	AOSTRA	Oil Sands
1982-	C. Thompson	MRC	Cell Adhesion

SECTION 3: UNIVERSITY AND DEPARTMENTAL ADMINISTRATIVE COMMITTEES

3.1 University and Faculty Committees

Duration	Position and/or Duties
1972-75	Undergraduate Studies Committee
1974	Search Committee Chairman Chem. Eng.
1975	Search Committee Chairman Mech. Eng.
1975-76	Research Committee
1979	Senior Promotions
1981-	SGS, Division III Executive Committee
1982-85	SGS, Council

3.2 Departmental Committee

Duration	Position and/or Duties
1971-75	Undergraduate Studies Committee (last three years as chairman)
1975-76	Graduate Studies Committee
1976-77	Seminar co-ordinator
1979	UTME Committee on Research Associates

SECTION 4: TEACHING

4.1 Undergraduate Teaching

Year	Subject No. & Title	No. of Students	Year and Course	lect/ week	Wt
1969	Introduction to Materials Science		4th Chem. Eng.		
1970	Materials Science II		4th Eng. Sci.		
1971-73	Differential Equations		2nd MEC 261F		
1972	Fluid Mechanics and Heat Transfer		3rd MEC 348		
1973	Transport Phenomena		3rd MEC 349		
1974	Differential Equations	100	2nd MEC 261F	3	12
1974	Thermodynamics	100	3rd MEC 321F	3	12
1975	Transport Phenomena	25	3rd MEC 349S	3	12
1975	Differential Equations	100	2nd MEC 261F	3	12
1975	Thermodynamics	100	3rd MEC 321F	3	12
1976	Differential Equations	100	2nd MEC 261F	3	12
1976	Thermodynamics	100	3rd MEC 321F	3	12
1978	Advanced Thermodynamics	25	4th MEC 421F	2	12
1978	Differential Equations	100	2nd MEC 261F	3	12
1979	Differential Equations	120	2nd MEC 261F	3	12
1979	Advanced Thermodynamics	15	4th MEC 421F	2	12
1980	Differential Equations	140	2nd MEC 261F	3	12

4.1 Undergraduate Teaching cont'd

Year	Subject No. & Title	No. of Students	Year and Course	lect/ week	Wt
1980	Advanced Thermodynamics	15	4th MEC 421F	2	12
1981	Differential Euations	130	2nd MEC 261F	3	12
1981	Advanced Thermodynamics	24	4th MEC 421F	2	12

4.2 Graduate Teaching

Year	Subject & Title		No. of Students
1972	Surface Phenomena	1109X	6
1973	Surface Phenomena	1109X	6
1973	Thermodynamics II	1101X	15
1974	Surface Phenomena	1109X	6
1974	Thermodynamics II	1101X	15
1975	Surface Phenomena	1109X	8
1975	Thermodynamics II	1101X	15
1976	Surface Phenomena	1109X	6
1976	Thermodynamics II	1101X	25
1977	Surface Phenomena	1109X	6
1979	Surface Phenomena	1109X	8
1979	Thermodynamics	1101X	20
1980	Surface Phenomena	1109X	4
1980	Thermodynamics	1101X	15
1981	Surface Phenomena	1109X	5
1981	Thermodynamics	1101X	16
1982	Surface Phenomena	1109X	3

4.3 Undergraduate Thesis Supervision

Year	Student Name	Thesis Topic
1982	J.C. Walker	Centrifugal Separator. Design, Construction and Testing
	E. Ho	Design and Construction of an Environmental Chamber for Contact Angle Measurements of Biological Materials
	M.R. Thompson	Modification of Roller Skis
	E.R. Marans	Investigation of Forces Involved in Engulfing Experiments of Particles in an Inclined System
	W-K. Park	Adhesion and Friction of Small Particle

SECTION 5: PUBLICATIONS

5.1 Refereed Journal Publications
(Write as for NSERC forms)

Number of publications prior to 1975: 56

1. Neumann, A.W., van Oss, C.J. and Zingg, W. "Thermodynamic Aspects of Phagocytosis and Thrombosis", Klin. Wschr. 53, pp. 1021-1027, 1975.

2. Hum, O.S., Neumann, A.W. and Zingg, W. "Platelet Interaction with Smooth Solid Substrates Determined by an Open Static Method", Trombosis Research 7, pp. 461-470, 1975.

3. Eick, J.D., Good, R.J. and Neumann, A.W. "Thermodynamics of Contact Angles II. Rough Solid Surfaces", J. Colloid Interface Sci. 53, pp. 235-248, 1975.

4. Abdelmessih, A.H., Neumann, A.W. and Yang, S.W. "The Effect of Surface Characteristics on Dropwise Condensation", Letters in Heat and Mass Transfer 2, pp. 285-292, 1975.

5. Neumann, A.W., Hope, C.J., Ward, C.A., Herbert, M.A., Dunn, G.W. and Zingg, W. "The Role of Surface Thermodynamics in thromboresistance of biomaterials", J. Biomed. Mater. Res. 9, pp. 127-142, 1975.

6. McCammond, D., Neumann, A.W. and Natarajan, N. "Strength of Glass Rods in Polar and Non-polar Liquids", J. Am. Ceramic Soc. 58, pp. 15-17, 1975.

7. Purdon, A.D., Tinker, D.O. and Neumann, A.W. "Detection of Lipid Phase Transitions by Surface Tensiometry", Chemistry and Physics of Lipids 17, pp. 344-352, 1976.

8. Omenyi, S.N. and Neumann, A.W. "Thermodynamic Aspects of Particle Engulfment by Solidifying Melt", J. Appl. Phys. 47, pp. 3956-3962, 1976.

9. van Oss, C.J., Zingg, W., Hum, O.S. and Neumann, A.W. "Platelet Activation on Agar/Agarose Gel Surfaces: Variation Correlated with Casting Technique and Hydrophobic/Hydrophilic Balance as Reflected in Contact Angle Measurements", Thrombosis Research 11, pp. 183-191, 1977.

10. van Oss, C.J. and Neumann, A.W. "Comparison Between Antigen-Antibody Binding Energies and Interfacial Free Energies", Immunological Communications 6, pp. 341-354, 1977.

11. Boruvka, L. and Neumann, A.W. "Generalization of the Classical Theory of Capillarity", Journal of Chemical Physics 66, pp. 5464-5476, 1977.

5.1 Refereed Journal Publications cont'd
(Write as for NSERC forms)

12. Chang, S.K., Hum, O.S., Moscarello, M.A., Neumann, A.W., Zingg, W., Leutheusser, H.J. and Ruegsegger, B. "Platelet Adhesion to Solid Surfaces. The Effects of Plasma Proteins and Substrate Wettability", Medical Progress Through Technology 5, pp. 57-66, 1977.

13. Rapacchietta, A.V. and Neumann, A.W. "Force and Free Energy Analyses of Small Particles at Fluid Interfaces II", Spheres. J. Colloid Interface Sci. 59, pp. 555-567, 1977.

14. Rapacchietta, A.V., Neumann, A.W. and Omenyi, S.N. "Force and Free Energy Analyses of Small Particles at Fluid Interfaces I", Cylinders. J. Colloid Interface Sci. 59, pp. 541-554, 1977.

15. van Oss, C.J., Good, R.J., Neumann, A.W., Wieser, J.D. and Rosenberg, P. "Comparison Between Attachment and Detachment Approaches to a Quantitative Study of Cell Adhesion to Low Energy Solids", J. Colloid Interface Sci. 59, pp. 505-515, 1977.

16. van Oss, C.J., Neumann, A.W., Omenyi, S.N. and Absolom, D.R. "Repulsive van der Waals Interactions: Their Role in Various Separation Methods", Sep. Purif., Meth. 7, pp. 245-271, 1978.

17. Neumann, A.W., Abdelmessih, A.H. and Hameed, A. "The Role of Contact Angles and Contact Angle Hysteresis in Dropwise Condensation Heat Transfer", International Journal of Heat and Mass Transfer 21, pp. 947-953, 1978.

18. Katona, E., Neumann, A.W. and Moscarello, M.A. "The Temperature Dependence of the Surface Tension of Aqueous Solutions of Plasma Proteins", Biochimica et Biophysica Acta 534, pp. 275-284, 1978.

19. Katona, E., Wood, D.D., Neumann, A.W. and Moscarello, M.A. "The Application of Surface Tension Measurements to the Study of Protein - Liquid Interactions Between a Hydrophobic Myelin Protein (lipophilin) and Lipids", J. Colloid Interface Sci. 67, pp. 108-117, 1978.

20. Boruvka, L. and Neumann, A.W. "An Analytical Solution of the Laplace Equation for the Shape of Liquid Surfaces Near a Stripwise Heterogeneous Wall", J. Colloid Interface Sci. 65, pp. 315-330, 1978.

21. van Oss, C.J., Omenyi, S.N. and Neumann, A.W. "Negative Hamaker Coefficients II. Phase Separation of Polymer Solutions", Colloid and Polymer Science 257, pp. 737-744, 1979.

22. Neumann, A.W., Economopoulos, O., Boruvka, L. and Rapacchietta, A.V. "Free Energy Analysis of Hetrogeneous Cylindrical Particles at Fluid Interfaces", J. Colloid Interface Sci., pp. 293-300, 1979.

5.1 Refereed Journal Publications cont'd
(Write as for NSERC forms)

23. Neumann, A.W., Moscarello, M.A., Zingg, W., Hum, O.S. and Chang, S.K. "Platelet Adhesion from Human Blood to Bare and Protein Coated Polymer Surfaces", J. Polymer Sci. 66, pp. 391-398, 1979.

24. van Oss, C.J., Absolom, D.R. and Neumann, A.W. "Repulsive van der Waals Forces II. Mechanism of Hydrophobic Chromatography", Sep. Sci. Technol. 14, pp. 305-317, 1979.

25. Neumann, A.W., Absolom, D.R., Zingg, W. and van Oss, C.J. "Surface Thermodynamics of Leukocyte and Platelet Adhesion to Polymer Surfaces", Cell Biophysics 1, pp. 79-92, 1979.

26. van Oss, C.J., Absolom, D.R., Grossberg, A.L. and Neumann, A.W. "Repulsive van der Waals Forces I. Complete Dissociation of Antigen-Antibody Complexes by Means of Negative van der Waals Forces", Immunol. Commun. 8, pp. 11-29, 1979.

27. Neumann, A.W., Omenyi, S.N. and van Oss, C.J. "Negative Hamaker Coefficients I. Particle Engulfment or Rejection at Solidification Fronts", Colloid and Polymer Science 257, pp. 413-419, 1979.

28. Absolom, D.R., van Oss, C.J., Genco, R.J., Francis, D.W. and Neumann, A.W. "Surface Thermodynamics of Normal and Pathological Human Granulocytes", Cell Biophysics 2, pp. 113-126, 1980.

29. Omenyi, S.N., Smith, R.P. and Neumann, A.W. "Determination of Solid/Melt Interfacial Tensions and of Contact Angles of Small Particles from the Critical Velocity of Engulfing", J. Colloid Interface Sci. 75, pp. 117-125, 1980.

30. Neumann, A.W., Hum, O.S., Francis, D.W., Zingg, W. and van Oss, C.J. "Kinetic and Thermodynamic Aspects of Platelet Adhesion from Suspension to Various Substrates", J. Biomed. Mater. Res. 14, pp. 499-509, 1980.

31. van Oss, C.J., Neumann, A.W. and Absolom, D.R. The "Hydrophobic Effect: Essentially a van der Waals Interaction", Colloid and Polymer Sci. 258, pp. 424-427, 1980.

32. Neumann, A.W., Absolom, D.R., Francis, D.W. and van Oss, C.J. "Conversion Tables of Contact Angles to Surface Tensions", Sep. Purif. Methods 9, pp. 63-163, 1980.

33. van Oss, C.J., Absolom, D.R. and Neumann, A.W. "Applications of Repulsive van der Waals Forces Between Different Particles, Macromolecules or Cells in Liquids", Colloids and Surfaces 1, pp. 45-56, 1980.

5.1 Refereed Journal Publications cont'd
(Write as for NSERC forms)

34. Omenyi, S.N., Neumann, A.W. and van Oss, C.J. "Attraction and Repulsion of Solid Particles by Solidification Fronts. I. Thermodynamic Effects", J. Appl. Phys. 52, pp. 789-795, 1981.

35. Omenyi, S.N., Neumann, A.W., Martin, W.W., Lespinard, G.M. and Smith, R.P. "Attraction and Repulsion of Solid Particles by Solidification Fronts. II. Dimensional Analysis", J. Appl. Phys. 52, pp. 796-802, 1981.

36. Abdelmessih, A.H., Rotenberg, Y. and Neumann, A.W. "An Experimental Study of the Effects of Surface Characteristics and Material Thermal Properties on Dropwise Condensation", Can. J. Chemical Eng. 59, pp. 138-148, 1981.

37. Zingg, W., Neumann, A.W., Strong, A.B., Hum, O.S.and Absolom, D.R. "Platelet Adhesion to Smooth and Rough Hydrophobic and Hydrophillic Surfaces Under Conditions of Static Exposure and Laminar Flow", Biomaterials 2, pp. 156-158, 1981.

38. Omenyi, S.N., Snyder, R.S., van Oss, C.J., Absolom, D.R. and Neumann, A.W. "Effects of Zero van der Waals and Zero Electrostatic Forces on Droplet Sedimentation", J. Colloid Interface Sci. 81, pp. 402-409, 1981.

39. van Oss, C.J., Beckers, D., Engelfriet, Absolom, D.R. and Neumann, A.W. "Elution of Bloodgroup Antibodies I. Red Cell Antibodies", Vox Sanguis 40, pp. 367-371, 1981.

40. Omenyi, S.N., Chappuis, J. and Neumann, A.W. "Adhesion of Small Spherical Particles to Substrates Immersed in Liquids", J. Adhesion 13, pp. 131-139, 1981.

41. van Oss, C.J., Absolom, D.R., Neumann, A.W. and Zingg, W. "Determination of the Surface Tension of Proteins. I. Surface Tension of Native Serum Proteins in Aqueous Media", Biochimica Biophysica Acta 670, pp. 64-73, 1981.

42. Absolom, D.R., van Oss, C.J., Neumann, A.W. and Zingg, W. "Determination of the Surface Tension of Proteins. II. Surface Tension of Proteins Altered at Liquid Air Interface", Biochimica Biophysica Acta 670, pp. 74-78, 1981.

43. Zingg, W., Hum, O.S., Absolom, D.R. and Neumann, A.W. "The Effect of Albumin Concentration and Storage Time on the Adhesion of Washed Porcine Platelets to Glass", Thrombosis Research 23, pp. 247-253, 1981.

5.1 Refereed Journal Publications cont'd
(Write as for NSERC forms)

44. Absolom, D.R., van Oss, C.J., Zingg, W. and Neumann, A.W. "Phagocytosis as a Surface Phenomenon. VI. Opsonization by Aspecific Adsorption of IgG as a Function of Bacterial Hydrophobicity", J. Reticuloendothelial Soc. 31, pp. 59-70, 1982.

45. Absolom, D.R., van Oss, C.J. and Neumann, A.W. "Elution of Human Granulocytes from Nylon Fibres by Means of Repulsive van der Waals Forces", Transfusion 21, pp. 663-674, 1982.

46. Neumann, A.W., Omenyi, S.N. and van Oss, C.J. "Attraction and Repulsion of Solid Particles by Solidification Fronts. III. Van der Waals Interactions", J. Phys. Chem. 86, pp. 1267-1270, 1982.

47. Absolom, D.R., Francis, D.W., Zingg, W., van Oss, C.J. and Neumann, A.W. "Phagocytosis of Bacteria by Platelets: Surface Thermodynamics", J. Colloid Interface Sci. 85, pp. 168-177, 1982.

48. Zingg, W., Absolom, D.R., Hum, O.S., Strong, A.B. and Neumann, A.W. "Platelet Adhesion to Smooth and Rough Surfaces", Canadian J. Surgery 25, pp. 16-19, 1982.

49. Vargha-Butler, E.I., Neumann, A.W. and Hamza, H.A. "Specific Heats of Polymer Powders by Differential Scanning Colorimetry", Can. J. Chem. (in press), 1982.

50. Omenyi, S.N., Snyder, R.S., Absolom, D.R., van Oss, C.J. and Neumann, A.W. "Enhanced Erythrocyte Suspension Layer Stability Achieved by Surface Tension Lowering Additives", Dispersion Science, Accepted for publication.

51. Vargha-Butler, E.I., Soulard, M.R., Hamza, H.A. and Neumann, A.W. "Determination of Specific Heats of Coal Powders by Differential Scanning Colorimetry", Fuel, Accepted for publication.

52. van Oss, C.J., Neumann, A.W. and Absolom, D.R. "Possible Contribution of Repulsive van der Waals Interactions to the Phase Separation of Stearyl Alcohol Coated Colloidal Silica Spheres and Polystyrene Molecules in Cyclohexane", J. Colloid Interface Sci., Accepted for publication.

5.2 Refereed Conference Papers Published in Proceedings
(Identify invited papers)

1. Neumann, A.W., Zingg, W. and Hum, O.S. "Adhesion of Platelets to Smooth Solid Surfaces", Biomedizinische Technik 20, pp. 57-58, 1975.

2. Neumann, A.W., Harnoy, Y., Stanga, D. and Rapacchietta, A.V. "Temperature Dependence of Contact Angles on Polyethylene Terephthalate", Colloid and Interface Science, M. Kerker, Ed., Vol. 3, pp. 301-312, 1976.

3. Neumann, A.W., Chang, S.K., Moscarello, M.A., Zingg, W., Hum, O.S. and Ruegsegger, B. "Interaction of Pig Platelets in Low Protein Suspensions with Glass, Polymers and Protein Surfaces", Biomedizinische Technik 21, pp. 77-78, 1976.

4. Neumann, A.W. Contact Angles, in "Wetting, Spreading and Adhesion", J.F. Padday, Ed., Academic Press, New York, pp. 3-35, 1978. (invited).

5. Absolom, D.R., Neumann, A.W., Zingg, W. and van Oss, C.J. "Thermodynamic Studies of Cellular Adhesion", Trans. Am. Soc. Artif. Intern. Organs 15, pp. 152-158, 1979.

6. van Oss, C.J., Absolom, D.R. and Neumann, A.W. "The Antigen-Antibody Complex and Erythrocyte Destruction, Physico-Chemical Considerations. Immunobiology of the Erythrocyte, Sandler, S.G., Nusbacher, J. and Schanfield, M.S., Alan R. Liss and Co., New York, pp. 157-169, 1980.

7. van Oss, C.J., Neumann, A.W. Good, R.J. and Absolom, D.R. "The Influence of Extremely Small Attraction as Well as Repulsive van der Waals Forces on Cell Interactions", Bioelectrochemistry: Ions, Surfaces, Membranes, ACS, Blank, M., ed., Adv. Chem. Ser. 188, pp. 107-114, 1980.

8. Vargha-Butler, E.I., Soulard, M.R., Neumann, A.W. and Hamza, H. "Contact Angle Measurements on Coal Particles from Solidification Front Experiments", Canadian Mining and Metallurgical Bulletin, pp. 1-5, December 1981.

9. Smith, R.P., Omenyi, S.N. and Neumann, A.W. "The Solidification Front Technique: Its Scope and Use to Determine Interfacial Tensions", Proceedings of the International Symposium on Physicochemical Aspects of Polymer Surfaces, N.Y. City, Accepted for publication, 1981. (invited).

10. Omenyi, S.N., Snyder, R.S., van Oss, C.J., Absolom, D.R. and Neumann, A.W. "Reduction of Droplet Formation and Sedimentation of Fixed Erythrocytes in Stationary and Flowing Systems", Allen, R.C. and Amand, P., eds., pp. 961-970, Gruyter, New York, 1981.

5.2 Refereed Conference Papers Published in Proceedings cont'd
(Identify invited papers)

11. Zingg, W., Absolom, D.R., Francis, D.W., van Oss, C.J. and Neumann, A.W. "Platelet Phagocytosis as a Model for Platelet Adhesion", Proc. 2nd Ann. European Biomaterials Meeting, in press, 1982.

12. Zingg, W., Neumann, A.W., van Oss, C.J., Absolom, D.R., Hum, O.S. and Francis, D.W. "A Thermodynamics Model for the Assessment of Leukocyte and Platelet Adhesion", Biomaterials 1980, Winter, G.D., Gibbons, D.F. and Plenk, Jr., H., eds., pp. 487-492, John Wiely and Sons, Ltd., New York, 1982.

13. van Oss, C.J., Absolom, D.R. and Neumann, A.W. "Role of Attractive and Repulsive van der Waals Forces in Affinity and Hydrophobic Chromatography", Affinity Chromatography and Related Techniques, Gribnau, T.C.J., Visser, J. and Nivard, R.J.F., eds., pp. 29-37, Elsevier, Amsterdam, 1982.

5.3 Books, Chapters in Books, UTME Series, Review Articles, and Non-technical Articles

1. van Oss, C.J., Gillman, C.F. and Neumann, A.W. "Phagocytic Engulfment and Cell Adhesiveness as Cellular Surface Phenomena", Marcel Dekker, Inc., New York, 160 pages, 1975.

2. Neumann, A.W. and Rapacchietta, A.V. "Comments to J.R. Huntsberger: Surface Chemistry and Adhesion - A Review of Some Fundamentals", Journal of Adhesion 9, pp. 87-91, 1977.

3. Neumann, A.W. and Good, R.J. Techniques of Measuring Contact Angles, in "Experimental Techniques in Surface Science", Vol. 11, Good, R.J. and Stromberg, R., eds., Plenum, New York, pp. 31-91, 1979.

4. Zingg, W., Hum, O.S., Moscarello, M.A. and Neumann, A.W. "Thermodynamics of Platelet Adhesion; in Hastings, G.W. and William, D.F. (ed.), Mechanical Properties of Biomaterials, Chapt. 46, John Wiley & Sons, New York, pp. 541-546, 1980.

5. van Oss, C.J., Absolom, D.R. and Neumann, A.W. "Phagocytosis as a Surface Phenomenon", The Reticuloendothelial System, Vol. 4, Friedman, H., Escobar, M.R. and Reicher, S.M., eds. Plenum Press, 1982.

6. Neumann, A.W., Absolom, D.R., Francis, D.W., van Oss, C.J. and Zingg, W. "Thermodynamic Aspects of Cellular Engulfment and Adhesion", Biocompatible Polymers: Science and Technology, Szycher, M., ed. J. Wiley and Sons, in press, 1982.

7. Absolom, D.R., van Oss, C.J., Zingg, W. and Neumann, A.W. "Protein and Platelet Interaction with Polymer Surfaces, Biomedical Materials: Blood Compatibility, Sharma, C., ed., Accepted for publication.

5.4 Patents

Two German patents, dealing with equipment for measuring surface tensions and contact angles.

A.W. Neumann

Professional expertise

: Many years of experience both with fundamental and applied aspects of surface and colloid science.

1. Development of novel experimental techniques:
   a. Very recently we developed a method to measure liquid/liquid interfacial tensions from the shape of sessile and pendant drops. The technique is free of the difficulties of the spinning drop technique.
   b. Development of novel strategies of determining the wettabilities of small particles, such as clay. These strategies depend on the quantitative interpretation of the interaction of the unknown particles with flat and smooth surfaces of known surface properties.
2. Modelling of interactions in dispersed systems:
   a. We developed quantitative thermodynamic models which describe the equilibrium of small particles at liquid/fluid interface. This analysis is crucial for the study of oil/water emulsions which are stabilized by small (clay) particles.
   b. We have worked extensively on the quantitation of the relation between surface thermodynamic free energy balances and van der Waals forces. The outcome of this work allows a direct use of the DLVO theory to describe stability and interactions in colloidal systems quantitatively.

We have published extensively on all of these topics.

SHAMOIL NIKKHOO-HAMADANI, B.Sc.

Research Associate, Technical Development Department

Mr. Nikkhoo-Hamadani is a research engineer broadly experienced in oil refinery operations including trouble shooting, programming, process planning, and research development. The latter included applied research in the manufacturing and use of some petroleum products which resulted in the assignment of five patents to the National Iranian Oil Company (N.I.O.C.)

EDUCATION:

1954 B.Sc., Petroleum Engineering, Abadan Petroleum Institution, Iran

PROFESSIONAL ASSOCIATIONS:

Association of Asphalt Paving Technologists (U.S.A.)
Asphalt Institute (U.S.A.)
Iranian Engineering Society
Iranian Petroleum Institute
Chemical Institute of Canada

EXPERIENCE:

Since 1980 THE SNC GROUP - SURVEYER, NENNIGER & CHÊNEVERT INC., Montréal

Research Engineer, Technical Development Department
- Coinvestigator for technical assessment of coal liquefaction processes (SRC-II, FHP and supercritical gas extraction).
- Principal investigator for characterization of bituminous and coal materials and related products.

1949-80 NATIONAL IRANIAN OIL COMPANY, Tehran, Iran

Research Manager, N.I.O.C. Research Centre
- Worked in cooperation with Exxon Research and Engineering Group in the following projects from 1977 to 1980:
  - Manufacturing of bitumen type products for various applications from which manufacturing processes for cutback specialties for cold applications in roofing were patented
  - Suitability of bitumen were determined through physical characterization, viscosity grading and analysis of asphalt pavements. The asphalt analysis was carried out in order to evaluate the changes in the properties of bitumens, due to exposure to outdoor effects.

SHAMOIL NIKKHOO-HAMADANI, B.Sc. (cont'd)

- Trouble shooting in the following areas:
  - Improvement of the operating conditions in bitumen plant to produce on spect oxidized grade bitumens
  - Increase of asphalt cement product, using refinery by-products such as PDA
  - Factors and their effects, causing the failure in asphalt pavement were investigated for big cities and highways and solutions were recommended to the authorities.

- Had direct responsibility in the following projects (1973-77):
  - Manufacture of anionic, cationic and clay bitumen emulsions which were first made in the laboratory and then in a homemade pilot plant (1 ton/d). This resulted in the ordering of a 20 ton/hr plant to be built in the refinery (three processes were patented). These products were used in:
    - Asphalt brick manufacturing as a low cost construction material, in which clay emulsion was used (patented in Iran)
    - Agriculture, for early germination and water conservation
    - Water seepage control.

Group Leader

- In charge of the Petroleum Products Research Group (1967-73) working on the following projects:
  - Bitumen emulsions
  - Production of spray oil for fruit trees (in the paste and oily states)
  - Production of weed killers, using emulsified aromatic hydrocarbons (a field test carried out in large water canals with 200 ppm of the product in water)
  - Sand stabilization together with planting. This project carried out by preparation and application of Mulch (a residual product) and used for stabilization of 60,000 hectares of active sand dunes in Iran, during 9 years.
- Trouble shooting in the following areas:
  - Lowering gas oil's pour point and CFPP (+20° to -20°F and +1° to -16° C respectively) using additive, to prevent wax cristal formation in gas oil in cold weather
  - Soap base greases evaluation and standardization (acting as the chairman in grease specification committee).

Senior Research Engineer, Research Centre, Tehran, Iran (1963-67)

- Research on manufacturing of industrial lubricating oils, including compressor, hydraulic, refrigerator, tractors, turbines, gears, white oil and transformer oil, from which tractor oil was formulated and manufactured.

SHAMOIL NIKKHOO-HAMADANI, B.Sc. (cont'd)

- Research on bitumen products and their specifications, comparing the specifications of bitumens in most countries and different types of grades in specified applications.
- Equipping of bitumen and lubricating oil research laboratories.
- Work on coal tar pitch, manufacturing of pipe coating enamel and high-softening-point bituminous materials and briquettes.
- Analysis and evaluation of rock asphalts from different locations and investigation into their applications.
- Work on bitumen emulsion manufacturing.

Program and Process Planner, Abadan Refinery, Abadan, Iran (1961-63)

- Participated in aviation and motor gasoline fields together with production and tinning of middle distillates and solvents.

Shift Control and Supervisor, Abadan Refinery, Abadan, Iran (1954-61)

- Gas plant process units, bitumen section and distillation units and washeries, in Abadan Refinery, Iran.

University courses and oil refinery training at the Abadan Petroleum Institute, Abadan, Iran (1949-54) sponsored by the Anglo-Iranian Oil Company (A.I.O.C.) which later became the National Iranian Oil Company (N.I.O.C.)

snc

LANGUAGES:

English
Farsi
French (limited)

REFERENCES

Theng, B.K.G., The Chemistry of Clay-Organic Reactions.
Wiley and Sons, New York, 1970.

Becker, P., Emulsions: Theory and Practice, 2nd edition,
Remhold, New Yoir, 1965.

Kitchener, J.A. and P.R. Musselwhite, "The Theory of Stability of Emulsions",
in Emulsion Science (ed. P. Sherman), Academic Press, London (1968).

Mortland, M.M., "Clay-Organic Complexes and Interaction"
Advances Agronomy, 22, 75-117 (1970)

B.J. Carroll,"The Stability of Emulsions and Mechanisms of Emulsion
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Schulman J.H. and J. Leja, "Control of Contact Angles at the Oil-Water
Solid Interfaces, Emulsions Stabilized by Solid Particles ($BaSO_4$)",
Trans. Faraday Soc., 50, 598-605 (1954).

DAVID G. COOPER, PH.D.

EDUCATION

1966 - 1970 — Mathematics, Physics and Chemistry programme at University of Toronto, B.Sc. (Honours Chemistry), 1970

1970 - 1976 — Lash Miller Chemical Laboratories, University of Toronto, Ph.D. (Inorganic Chemistry), 1976

EXPERIENCE

1976 - 1981 — Research Associate, Faculty of Engineering Science, University of Western Ontario
- directed research contracts in the following areas:
  - microbially enhanced oil recovery
  - emulsion coalescence
  - biosurfactant production and characterization

1979 - 1981 — Assistant Professor, Part-Time, Faculty of Engineering Science, University of Western Ontario
- lectured graduate and undergraduate courses in water pollution control

From June 1, 1981 — NSERC Research Fellow, Department of Chemical Engineering, McGill University
- biotechnology research programme
- ongoing research projects include:
  - microbially enhanced oil recovery
  - biosurfactant production and characterization
  - cellulose degradation (chemical and biological)
  - uptake of metal ions by biomass
  - production of enzymes from industrial wastes

PROFESSIONAL AFFILIATIONS

Member, Chemical Institute of Canada
Member, American Society for Microbiology
Member, Canadian Society for Chemical Engineering
Member, American Oil Chemists Society

CURRENT RESEARCH GRANTS

NSERC Operating Grant ($12,000/year)
FCAC Operating Grant ($15,000/year)
FCAC Equipment Grant ($3,000)

FULL PAPERS IN REFEREED SCIENTIFIC JOURNALS

D.G. Cooper and J. Powell (1973). Mechanism of Tertiary Phosphine Catalized Isomerization of Tetragonal Planar Platinum (II) Complexes. J. Amer. Chem. Soc., 95, 1102-1108.

D.G. Cooper and J. Powell (1973). Mechanistic Studies of Isomerization Reactions of Tetragonal Planar Tertiary Phosphine Complexes of Palladium. Canad. J. Chem., 51, 1634-1644.

J. Brown, D.G. Cooper and J. Powell (1973). Copper, Silver and Gold Annual Survey Covering the Year 1971. J. Organometal. Chem., 58, 411-441.

D.G. Cooper and J. Powell (1976). Carbon-13 Nuclear Magnetic Rsonance Studies of Platinum (II)-Olefin Bonds. Inorg. Chem., 15, 1959-1968.

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D.G. Cooper, J.E. Zajic and D.F. Gerson (1979). Production of Surface-Active Lipids by Corynebacterium lepus. Appl. Environ. Microbiol., 37, 4-10.

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D.G. Cooper and J.E. Zajic (1980). Surface-Active Compounds from Microorganisms. Adv. Appl. Microbiol., 26, 229-253.

D.G. Cooper, J.E. Zajic, E. Cannell and J.M. Wood (1980). The Relevance of "HLB" to De-emulsification of a Mixture of Heavy Oil, Water and Clay. Can. J. Chem. Eng., 58, 576-579.

D.F. Gerson, D.G. Cooper, B.A. Ramsay and J.E. Zajic (1980). The Effect of Substrate on Inhibition of Corynebacterium lepus by Isonicotinic Acid Hydrazide (Isoniazid). Can. J. Microbiol., 26, 1498-1500.

D.G. Cooper, J.E. Zajic and C. Denis (1981). Surface Active Properties of a Biosurfactant from Corynebacterium lepus. J. Amer. Oil Chem. Soc., 58, 77-80.

C.R. Macdonald, D.G. Cooper and J.E. Zajic (1981). Surface Active Lipids from Nocardia erythropolis Grown on Hydrocarbons. Appl. Environ. Microbiol., 41, 117-123.

FULL PAPERS IN REFEREED SCIENTIFIC JOURNALS (continued)

J.E. Zajic, D.G. Cooper, J.A. Marshall and D.F. Gerson (1981). The Microstructure of Athabasca Tar Sand by Freeze-Fracture Preparation and Transmission Electron Microscopy. Fuel, 60, 619-623.

D.G. Cooper, C.R. Macdonald, S.J.B. Duff and N. Kosarid (1981). Enhanced Production of Surfactin from B. subtilis by Continuous Product Removal and Metal Cation Additions. Appl. Environ. Microbiol., 42, 408-412.

Z. Duvnjak, D.G. Cooper, and N. Kosaric (1981). Biosynthesis of Surfactant by Arthrobacter paraffineus ATCC 19558. Biotech. Bioeng., 24, 165-175.

J. Akit, D.G. Cooper, K.I. Manninen and J.E. Zajic (1981). The Investigation of Potential Biosurfactant Production among Phytopathogenic Bacteria and Related Soil Microbes. Current Microbiology., 6, 145-150.

W.L. Cairns, D.G. Cooper, J.E. Zajic, J.M. Wood and N. Kosaric (1982). Characterization of Nocardia amarae as a Potent Biological Coalescing Agent of Water-Oil Emulsions. Appl. Environ. Microbiol., 43, 362-366.

D.G. Cooper, J. Akit and N. Kosaric (1982). Surface Activity of the Cells and Extracellular Lipids of Corynebacterium fascians CF15. J. Ferment. Technol., 60, 19-24.

NOTES AND COMMUNICATIONS IN REFERRED SCIENTIFIC JOURNALS

D.G. Cooper, R.P. Hughes and J. Powell (1972). Studies of Carbon-13 Shielding Effects in Metal-Alkyl, Metal-Olefin and Metal-Alkyl Bonds. J. Amer. Chem. Soc., 94, 9244-9246.

J. Powell and D.G. Cooper (1973). cis-trans Isomerization and Ligand Exchange Reactions of an Isoquinoline-Platinum (II) Complex. Chem. Commun., 487-488.

D.G. Cooper, G.K. Hamer, J. Powell and W.F. Reynolds (1973). Carbon-13 Nuclear Magnetic Resonance Study of the Styrene-Platinum (II) Bond. Chem. Commun., 449-450.

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D.G. Cooper, K.J. Kennedy, D.F. Gerson and J.E. Zajic (1978). The Production of Extracellular Galactose by Arthrobacter globiformis Using Lactose as a Substrate. J. Ferment. Technol., 56, 550-553.

D.G. Cooper, J.E. Zajic, D.F. Gerson and K.I. Manninen (1980). Isolation and Identification of Biosurfactants Produced During Anaerobic Growth of Clostridium pasteurianum. J. Ferment. Technol., 58, 83-86.

D.G. Cooper, R. Longay, S.N. Liss and J.E. Zajic (1981). The Surface Activity of Mycobacterium and Pseudomonas. J. Ferment. Technol., 59, 97-101.

REFEREED PAPERS PUBLISHED IN FULL IN CONFERENCE PROCEEDINGS

D.G. Cooper, S.C. Nybury, J. Powell and K.A. Simpson (1974). Spectroscopic and Structural Studies of Platinum-Olefin Bonds. Proc. Int. Conf. Coord. Chem., 16th, R81-R84.

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J.E. Zajic, D.G. Cooper, W.L. Cairns and S.A. Kliza (1981). Biosurfactants and Surface Phenomena Associated with Corynebacterium lepus. Proceed. VIth Inter. Ferment. Symp. (1980). Adv. in Biotechnol., 3, 467-474.

D.G. Cooper (1982). Biosurfactants and Enhanced Oil Recovery. Proceedings of Microbial Enhancement of Oil Recovery, Afton, Oklahoma. in press (presented May, 1982).

PAPERS PRESENTED AT CONFERENCES

D.G. Cooper and J. Powell (1972). The Mechanism of Base Catalyzed Isomerization of Tetragonal Planar Platinum (II) and Palladium (II) Complexes. 55th CIC Conference, Quebec City, Canada.

D.G. Cooper and J. Powell (1975). ^{13}C.N.M.R. Data for Some Organo-Platinum (II) Compounds. 58th CIC Conference, Toronto, Canada.

D.G. Cooper, D.F. Gerson and J.E. Zajic (1978). The Characterization of a Surface Active Lipid from Corynebacterium lepus Utilizing Kerosene. 61st CIC Conference, Winnipeg, Canada.

D.G. Cooper and D.F. Gerson (1978). The Isolation and Characterization of a Surface Active Lipid from Corynebacterium lepus. Can. Fed. Biol. Sci., 21st Annual Meeting, London, Canada.

D.G. Cooper, J.E. Zajic and D.F. Gerson (1979). Surfactant Properties of Hydroxy-Carboxylic Acids Produced by Corynebacterium lepus. 62nd CIC Conference, Vancouver, Canada.

J. Brosseau, N. Kosaric and J.E. Zajic (1979). Microbial Production of Hydrogen. 62nd CIC Conference, Vancouver, Canada.

C.R. Macdonald, D.G. Cooper and J.E. Zajic (1980). Surface Active Neutral Lipids of Nocardia erythropolic. VIth International Fermentation Symposium, London, Canada.

D.G. Cooper and J.E. Zajic (1980). The Chemistry of Biosurfactants. Fessigner Memorial Lecture at the 1980 Meeting of the Texas and New Mexico Branches of the Amer. Soc. Microbiol., El Paso, U.S.A.

D.G. Cooper, C.R. Macdonald, S.J.B. Duff and N. Kosaric (1982). Production of Surfactin from Bacillus subtilis. American Oil Chemists' Society Annual Meeting, Toronto, Canada.

PH.D. THESIS

D.G. Cooper (1976). Spectroscopic and Kinetic Studies of Tetragonal Planar Complexes of Platinum (II) and Palladium (II). University of Toronto.

RESEARCH REPORTS

D.F. Gerson, J.E. Zajic, D.G. Cooper and M.D. Ouchi (1977). Microbial Separation of Bitumen from Athabasca Tar Sand, Part II. Biochemical Engineering Research Reports, University of Western Ontario, 3, 316 pages.

D.F. Gerson, J.E. Zajic and D.G. Cooper (1979). Microbial Separation of Bitumen from Athabasca Tar Sand, Part III. Biochemical Engineering Research Reports, University of Western Ontario, 5, 392 pages.

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D.G. Cooper, C.R. Macdonald, J. Akit, Z. Duvnjak, J.E. Zajic and N. Kosaric (1980). Evaluation of Surface Active Compounds Produced by Microorganisms, Part I. Biochemical Engineering Research Reports, University of Western Ontario, 7, 159 pages.

D.G. Cooper, W.L. Cairns and N. Kosaric (1980). De-emulsification and Microbes, Part 2. Biochemical Engineering Research Reports, University of Western Ontario, 8, 62 pages.

PATENT APPLICATION

J.E. Zajic and D.G. Cooper, De-emulsification Agents of Microbial Origin, Submitted in Canada by Hirons, Rogers and Scott, Sept. 1980, in U.S.A., August 1981.

T. HUY PHUNG QUACH, Ph.D. Eng.
174 Trenton Avenue
Town of Mount Royal, Québec
H3P 1Z3
Tel.: (514) 739-6956

CAREER OBJECTIVES: Process Design, Project Engineering, Research & Development

EDUCATION:

1975 — Ph.D. in Chemical Engineering, Ecole Polytechnique, University of Montreal, Montreal, Quebec.

1970 — M.A.Sc. in Chemical Engineering, Ecole Polytechnique, University of Montreal, Montreal Quebec.

1968 — B.A.Sc. in Chemical Engineering, University of Ottawa Ottawa, Ontario.

EXPERIENCE:

1978 - present — SNC/FW LTD.. Montreal, Quebec.

Senior Process Engineer

- Responsible for detailed process design of the C_3/C_4 splitter and Deisobutanizer towers, and for the development of heat and material balance for the hydrocracker unit including the regeneration and sulfiding cases for the Sunoco project.
- Responsible for detailed process design specifications of a Vacuum Unit for the Sunoco, Sarnia Hydrocracker Complex, including the development of the heat and material balance by means of the Process Simulator computer program and also, the optimization of heat integration schemes.
- Responsible for the complete preliminary design specifications for a new Sour Water Stripper for the Gulf Montreal refinery.

.../2

T. QUY PHUNG QUACH, Ph.D. Eng. (cont'd)

Intermediate Process Engineer

- Participation in the preparation of material and heat balances, development of detailed process flow sheets and preliminary engineering flow sheets. technical specifications for process equipment and instrumentation for a new hydrotreating unit and the revamp of cat cracker, cat light end. polyfractionation DEA and Merox units for IOL's Montreal refinery.
- Hydraulic performance review of existing pumps and instruments for IOL's hydrofiner and vacuum units in the Montreal refinery.
- Flare system review. Includes built-up back pressure and flare header size calculations. IOL Montreal refinery.
- Heat loss calculations for cat cracker waste heat recovery unit at IOL Montreal.

1974-78 ECOLE POLYTECHNIQUE, University of Montreal. Montreal. Quebec

Research Associate

- Design and set up of the system to study the kinetic of the oxidation of hydrocarbons and carbon oxides.
- Selection of the methods to analyse the chemical reaction products of chromatography.
- Supervision of the graduate students in their research programs.
- Lecturer of courses:
  - "Technique d'expérimentation et communication" at Chemical Engineering Department Ecole Polytechnique.
  - "Procédés chimiques" at Chemistry Department University of Quebec at Montreal.

1968-74 ECOLE POLYTECHNIQUE, CHEMICAL ENGINEERING DEPARTMENT Montreal Quebec

Research Assistant

- Develop non-linear regression analysis to determine the valid mechanism of chemical reactions.
- Set up a Dewar calorimeter to measure specific heat of binary hydrocarbon systems.

Teaching Assistant in the following courses:
- Analysis of Chemical Reactors
  Unit Operations

T. QUY PHUNG QUACH, Ph.D. Eng. (cont'd)

PUBLICATIONS:

- T.Q. Phung, "Geometric parameters for some flow channels". B.A. Sc. thesis. University of Ottawa, 1968.
- W. Kozicki, C. Tiu & T.Q. Phung. "Geometric parameters for some flow channels". Can. J. of Chem. Eng., Vol 46 No. 6. 389 1968.
- T.Q. Phung, "Heat capacities of binary mixtures", Master thesis, Ecole Polytechnique, University of Montreal, 1970.
- T.Q. Phung Quach, "Kinetics of the methane-steam reaction over nickel catalyst in a continuous stirred tank reactor", Ph.D. thesis, Ecole Polytechnique, University of Montreal. 1974.
- T.Q. Phung Quach & D. Rouleau, "Kinetics of the methane-steam reaction over nickel catalyst in a continuous stirred tank reactor", J. Appl. Chem. Biotechnol. Vol. 25, p. 445 1975.
- T.Q. Phung Quach & D. Rouleau, "Kinetics of the reaction between carbon dioxide-hydrogen over ruthenium catalyst in a continuous stirred tank reactor", J. Appl. Chem. and Biotechnol., Vol 26, p. 527-535, 1976.
- T.Q. Phung Quach, D. Rouleau, C. Chavarie & C. Laguerie, "Catalytic oxidation of benzene to maleic anhydride in a stirred tank reactor", Can. J. of Chem. Eng., Vol. 56. p. 72-77, 1978.
- O. Kiser, T.Q. Phung Quach, D. Klvana & B. Gilot. "Analyse chromatographique des produits de l'oxidation catalytique du benzène", J. of Chromatography. Vol. 151. p. 81-86, 1978.

SNC

PERSONAL:

Status: Married
Birth: 07 July 1944
Languages: English, French

MEMBERSHIPS:

Ordre des ingénieurs du Québec
Women in Science and Engineering

REFERENCES:

Available upon request

March 1983

THOMAS JOSEPH ADLEY, B.Sc., PH.D., DIC.

Special Projects Manager for SNC - Technitrol.
Associate Professor - Chemistry Department, Concordia University, Montreal.

Dr. Adley has had extensive experience in chemical spectroscopy, particularly in the fields of mass spectrometry, proton and C-13 magnetic resonance spectroscopy applied to structure determination of organic compounds. Recently he has directed experimental work related to coal deoxygenation, dehydrosulfurization and catalyst development.

EDUCATION:

1954-1958 B.Sc., Sir George Williams University, Montreal, Quebec.

1959-1962 Ph.D., DIC. Imperial College London University

1964-1966 Post Doctoral Fellow, Massachusetts Institute of Technology

1971-1972 Cambridge University England (Research Associate Sabbatical Year)

SNC - Technitrol

1980-Pres. Prior to 1980 Dr. Adley had acted as consultant to Technitrol for special problems relating to spectroscopy including those related to quantitative applications and structure determination. Since June of 1980 Dr. Adley has held the post of Manager for Special Projects at SNC - Technitrol. In this capacity he has supervised a number of projects related to coal liquefaction and bitumen. Dr. Adley continues to hold the position of Associate Professor of Chemistry at Concordia University, where he lectures on applications of chemical spectroscopy and organic stereochemistry.

SNC

1977-1980 Dr. Adley held the position of Assistant Dean in the faculty of Arts and Science with responsibility for curriculum development. During this period Dr. Adley published a number of papers in the field of mass spectrometry devoted to the elucidation of modes fragmentation of organic molecules under electron impact as well as of their proton and C-13 spectra.

1964-1977 Concordia University, Montreal, Quebec.

Dr. Adley held positions of Assistant and later Associate Professor of Chemistry at Concordia University(Formerly Sir George Williams University)

1962-1964 Dr. Adley held a post Doctoral Fellowship at MIT where he worked under the direction of Dr. J.C. Sheehan on the synthesis of oxy-anlogues of penicillin. During this time he was associated with the Research Institute for Medecine and Chemistry in Cambridge Mass, where he was responsible for research on the isolation of active peptides in the hypothalamus gland.

THOMAS JOSEPH ADLEY, B.Sc., Ph.D., DIC. (Cont'd)

PUBLICATION

Dr. Adley has published 16 scientific articles. A list of these is attached as an appendix if required.

LANGUAGES

English
German

snc

D. BRIAN WEBBER

Senior Consultant

Mr. Webber has more than fifteen years experience in the analysis and planning of corporate development and investment projects, with particular emphasis on industrial development and market strategy, export promotion, transportation and distribution. In recent years, much of his work has related to the impact of energy costs on regional and national development plans within each of these sectors.

EDUCATION:

1970	M.Sc., Economics and Operations Research, Cornell University, U.S.A.
1966	Civil Engineering, McGill University, Montreal, Canada.

LANGUAGES: English, French.

PROFESSIONAL ASSOCIATIONS:

Institute of Management Consultants of Quebec
Order of Engineers of Quebec.

SNC

EXPERIENCE:

Since 1982	SNC Inc., Montreal, Canada.
	Preparation of forecasts of local and national demand for electricity and evaluation of possibilities for international interconnection- Guinea.
1970- 1982	SORES Inc.,(The SNC Group) Montreal, Canada.
	Prefeasibility study to establish the preferred location of a world scale aluminium smelter, based on an assessment of comparative energy costs - Province of Newfoundland.
	Assessment of the comparative economics of various systems of creating useful energy from wood waste and determination of the market for such energy- Province of Ontario.

D. Brian Webber (cont'd)

EXPERIENCE (cont'd)

1970- 1982	Assessment of the socio-economic impact of the establishment of a pulp mill- Canadian International Paper Ltd.
	Analysis of the economic impact of changes in the method and cost of transportation on the logging and forest products industry in North Western Quebec- Canadian Transport Commission.
	Study of the economic development potential of the James Bay territory subsequent to the introduction of hydro-electric schemes to the region- James Bay Development Corporation.
	Assessment of the scale, timing and probability of implementation of major investment projects in the energy, mining and manufacturing sectors- British Columbia.
	Identification of opportunities for Canadian industry to establish industrial links and investments in Egypt- Canadian International Development Agency (CIDA).
	Assessment of the scale, timing, probability of implementation and financing requirements of major investment programs in twenty-one developing countries- Canadian Commercial Corporation.
	Evaluation of the cement industry in Benin- World Bank.
	Preparation of an expansion program based on availability and cost of energy for the cement industry in Burma- CIDA/ Ceramic Industries Corporation.
	Assessment of corporate plan and of requirements for maximization of positive regional impact of a grass-roots fertilizer plant- Indonesia.
	Preparation of an investment program for the cereals sector and planning of transportation systems and storage facilities - Tunisia/ World Bank.
	Preparation of industrial plan to create 40,000 jobs over 10 years in Suez Canal region, Egypt - Office for Projects Execution/ UNDP/ Government of Egypt.

D. Brian Webber (cont'd)

EXPERIENCE (cont'd)

Market research and organization assignments for a number of major enterprises- Algeria.

Technical and financial feasibility studies of two multiuse urban complexes- Province of Quebec.

Planning of optimal port facilities for major industrial park- Province of Quebec.

Study of STOL Air Service in isolated regions- Ministry of Transport, Canada.

Development of models for network planning and financial simulation of inter-regional telecommunications- Ministry of Communications, Canada.

Survey of Canadian traffic safety data systems- Ministry of Transport, Canada.

Operations research for airport planning and airline regulation - Federal Aviation Administration, U.S.A./ Ministry of Transport, Canada/Canadian Transport Commission.

Organization of the marketing and distribution division of the major company in the cereal products industry- Algeria.

Location and investment analysis for nationwide grain milling, storage and distribution facilities- Algeria.

Mission to review and implement nationwide fleet management system- CIDA/ Ministry of Agriculture, Tunisia.

1968- 1970 CORNELL UNIVERSITY

Teaching Assistant. Responsible for the conception, development and teaching of a course relating standard engineering techniques to the technical and economic constraints imposed by advanced technology.

1966- 1968 ST. LAWRENCE SEAWAY AUTHORITY

Staff Engineer. Operations research and systems analysis

BRIAN WEBBER (CONT'D)

EXPERIENCE (Cont'd)

1966- 1968 — related to vessels, locks and canals; conceptual engineering and preparation of cost estimates for major construction projects; economic feasibility analysis.

PUBLICATIONS:

"Wood Wastes to Energy, A Central Facility for a Town in Northern Ontario", Ontario Industrial Waste Conference, June 1976 (co-author).

"The Potential for STOL Air Service in Isolated Regions", Canadian Aeronautics and Space Journal, Vol. 19, No. 4, April 1973 (co-author).

Thesis: "A Method for the Application of Linear Programming to the Planning of Airport Passenger Terminals", Cornell University, January 1973.

"Planning Airport Snow and Ice Removal Using Operations Research Techniques", Highway Research Record, 1971 (co-author).

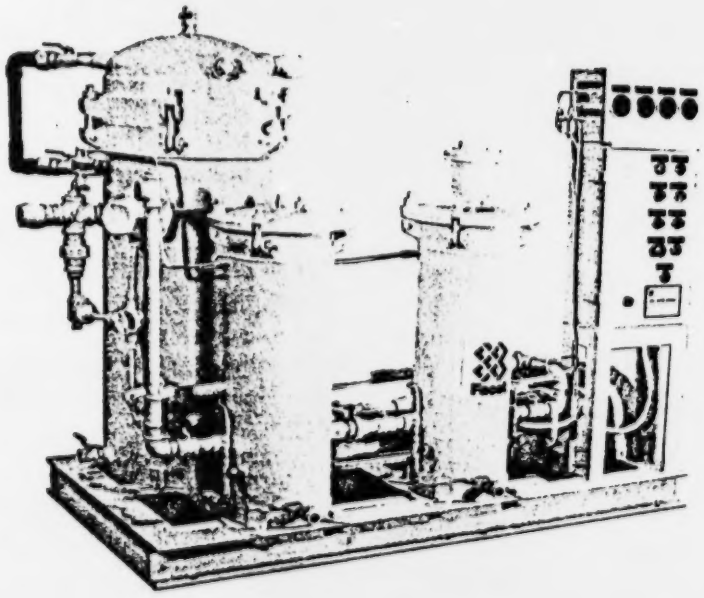
SNC

APPENDIX C

DESCRIPTION OF COMMERCIAL METHOD AND EQUIPMENT

Facet (OWS) Oil-Water Separator System

• MARINE • POWER • PETROLEUM • INDUSTRIAL • TRANSPORTATION



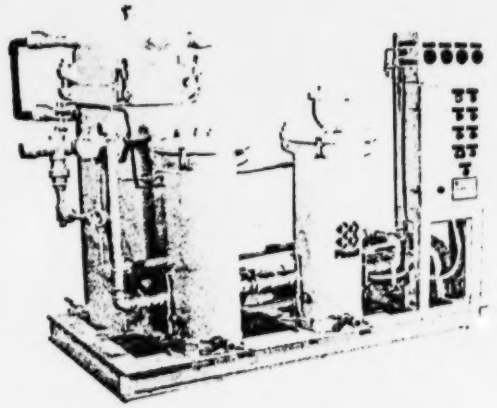
Facet

Industrial Division
Facet Enterprises, Inc.
P O Box 50098
Tulsa, Oklahoma 74150 U S A
(918) 834-2929 Telex: 49-2495

Bulletin 516
Printed in U S A

Facet

Oil-Water Separator System



MAJOR SYSTEM COMPONENTS

(1) PARALLEL PLATE SEPARATOR
(2) PREFILTER
(3) FINAL COALESCER
(4) PROGRESSIVE CAVITY PUMP
(5) AUTOMATIC OIL AND WATER CONTROL VALVES
(6) CONTROL STATION
(7) STURDY STRUCTURAL STEEL SKID

FEATURES

Facet Oil-Water Systems incorporate the use of a Parallel Plate Separator and a Final Polishing Stage. The Oil-Water Separator System provides these features:

(1) The Facet Parallel Plate Separator is designed to remove free and dispersed oil and oil-borne solids without the necessity of cartridges or any media replacement.

(2) The Facet Parallel Plate Separator will remove oil surges of 100% without increasing the oil content in the effluent significantly.

(3) Maximum oil removal by use of second stage Prefilter and third stage Coalescer to achieve removal of fine dispersed oil droplets under 50 micron in diameter.

(4) Since the Facet Parallel Plate Separator is the first stage to process the oil-water mixture, it will protect the polishing stage from excessive oil and solids contamination, thereby **extending cartridge life**.

(5) Facet Oil-Water Separator Systems are designed with the system pump downstream of the Parallel Plate Separator, which simulates gravity flow, and prevents further emulsification of the oil-water mixture to assure maximum oil removal.

(6) Facet's optional Oil Content Monitors will automatically sense and control the effluent should the oil content exceed the predetermined range by allowing the flow to continue through the Polishing Stage Prefilter and Coalescer vessels.

BENEFITS

✔Proven performance in various field applications.

✔System requires no chemicals; recovered oil contains no contaminating emulsion breakers.

✔Low operating and maintenance costs.

✔Performance is not affected by low or intermittent flow.

✔Meets tomorrow's discharge requirements today without the need to invest in additional equipment later.

✔Dual mode operation for 100 ppm or 15 ppm discharge requirements.

✔Recovers good quality oil which typically contains less than 0.5% water.

✔Single progressive cavity pump assures minimum emulsification.

✔Easy installation.

✔Fully automatic operation.

✔Will process up to 100% surges of oil.

✔Pressurized system eliminates escape of volatile vapors.

Facet

Oil-Water Separator System

APPLICATIONS

MARINE

- BILGE & BALLAST WATER
- SHIP BUILDING & REPAIR YARDS
- GAS FREEING OF BARGES
- COMMERCIAL MARINE PORTS

POWER

- BOILER FEED WATER
- COOLING WATER
- FLOOR DRAINS TURBINE ROOMS
- FUEL STORAGE STORM WATER RUNOFF

PETROLEUM

- STORM WATER FROM BULK STORAGE
- TANK BOTTOM CONDENSATE
- REFINERY WASTE WATER
- MOBILE OFFSHORE PLATFORMS

INDUSTRIAL

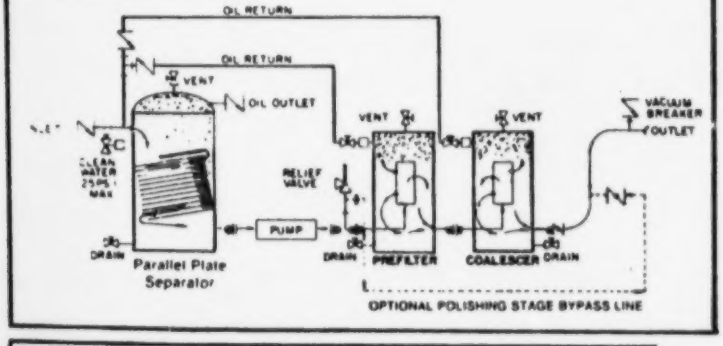
- PETRO-CHEM PLANTS
- STEEL MILLS
- MANUFACTURING PLANTS
- BOILER FEED WATER

TRANSPORTATION

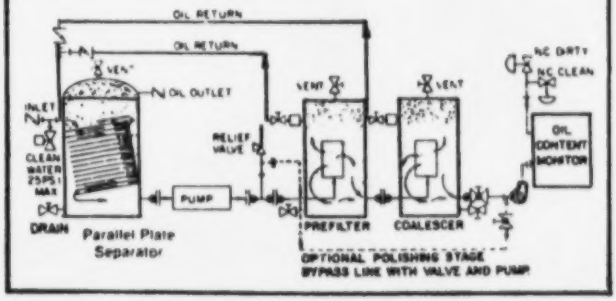
- RAILROAD YARD MAINTENANCE & WASHING
- TRUCKLOADING TERMINALS
- AIRPORT FUEL STORAGE & MAINTENANCE

FLOW SCHEMATICS

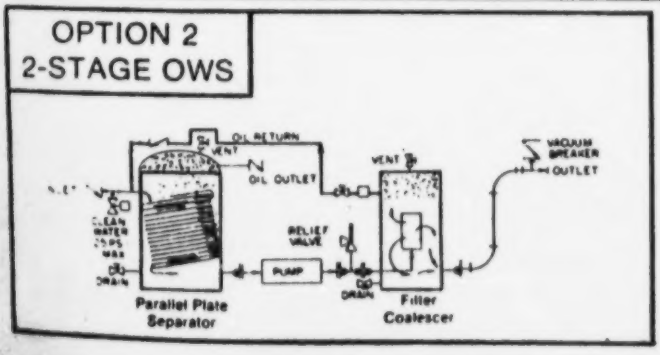
3-STAGE OWS



OPTION 1
OIL CONTENT MONITOR



OPTION 2
2-STAGE OWS



OPTION 1: 3-STAGE OWS SYSTEM WITH OIL CONTENT MONITOR & OPT. POLISHING STAGE BYPASS.

OPTION 2: 2-STAGE OWS SYSTEM

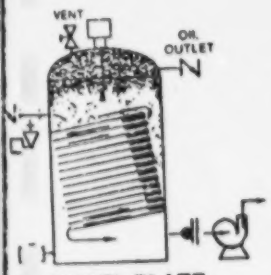
NOTE: OPTION 2 MAY ALSO BE SUPPLIED WITH OIL CONTENT MONITOR & POLISHING STAGE BYPASS.

Facet

Oil-Water Separator System

R NCIPLE OF OPERATION

PARALLEL PLATE SEPARATOR STAGE:

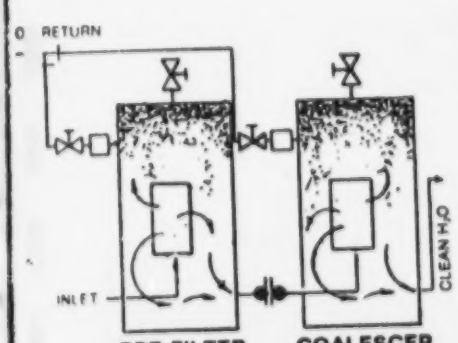


I RALLEL PLATE
1st STAGE

The plate separator is supplied with inlet connections for both oil-water and clean water. The oil-water inlet is equipped with a check valve and the clean water inlet is equipped with a solenoid valve to control a source of low pressure clean water. The solenoid valve is operated by a capacitance probe mounted in the plate separator with high and low set points. The capacitance probe also operates the system pump. As long as the interface is below the "LOW" set point on the capacitance probe, the system pump is "OFF" and the solenoid valve is "OPEN" to permit clean water into the plate separator. When the interface reaches the "HIGH" set point on the capacitance probe, the system pump is "ON" and the clean water solenoid valve is "CLOSED." The oil-water mixture is pulled into the plate separator by the negative pressure of the pump suction. As the mixture enters the separator, the inclined parallel plate arrangement allows the free and unemulsified oil and oil-borne solids to rise freely to the oil collection chamber. Any dispersed oil that does not rise freely continues with the water phase and is separated as it passes through the parallel plates. The dispersed oil droplets rise in accordance with Stokes' Law and impinge on the underside of the inclined parallel plates. The angle of the plates allow the collected oil droplets to migrate upward to a guide rib. This guide rib causes the droplets to flow into a vertical collection channel where they rise to the upper oil collection chamber without interference from the water flow. When the collected oil level reaches the "LOW" set point on the capacitance probe, the system pump stops and the clean water solenoid valve opens to pressure discharge the oil to storage. When the oil level reaches the "HIGH" set point on the capacitance probe, the clean water solenoid valve closes and the system pump starts the normal flow conditions.

Optional Facet Oil Content Monitors are available for monitoring and controlling effluent at this point to determine if additional separation is required per customer specifications. For additional separation, the Oil Content Monitor will automatically sense and control the effluent and divert the flow through the Facet Polishing Stage Prefilter and Final Coalescer when the oil content exceeds the predetermined range.

POLISHING STAGE:



PRE-FILTER
2nd STAGE

COALESCER
3rd STAGE

After passing through the Parallel Plate Separator, the oil-water mixture, with free and dispersed oil and oil-borne solid contaminants removed, is then pumped to the prefilter. The oil-water mixture flows through the filter cartridges removing gross solid contaminants and providing maximum protection to the final coalescer cartridges.

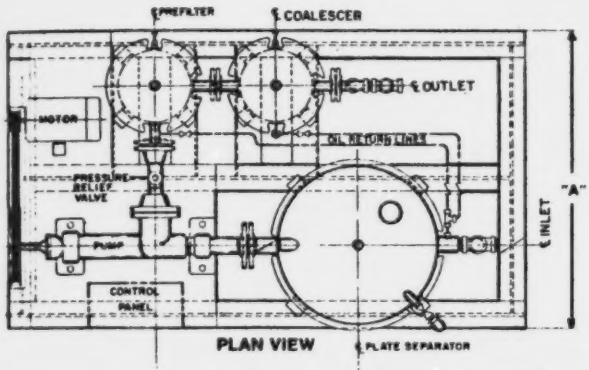
After passing through the Prefilter, the oil-water mixture with gross solid contaminants removed flows to the coalescer. The oil-water mixture flows through the coalescer cartridges where the principle of mechanical impingement and preferential wetting is used to break any remaining mechanical emulsion of oil and water. Effective mechanical coalescing is dependent on the proper selection of media which possesses an infinite number of small, irregular, continuous passages. These passages are such that by impingement, the emulsion is broken. Using the forces of gravity, the lighter liquid (oil) rises to the upper oil collection chamber and the water flows from the lower portion of the unit and is discharged from the system. An optional Facet Oil Content Monitor may also be installed to monitor the system discharge. Should the oil concentration in the effluent attain a higher level than permitted, the monitor may then divert the discharge, sound an alarm or shut the system down.

Oil, which is collected in the Prefilter and Coalescer vessels, is continuously bled back to the Parallel Plate Separator for automatic discharge. Both the Prefilter and Coalescer have a sight glass for visual detection of oil bleed rate to the Plate Separator.

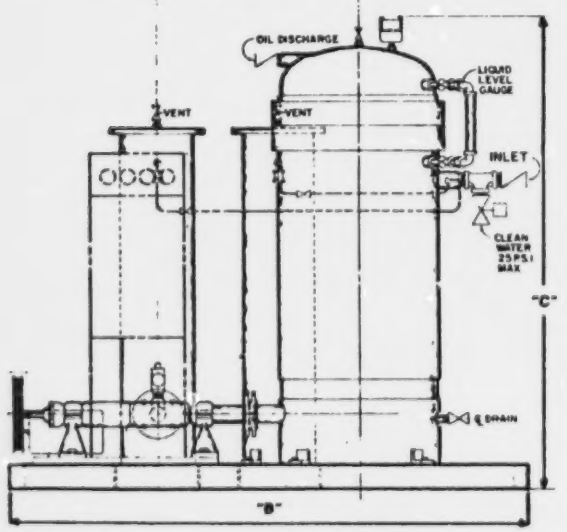
Facet

Oil-Water Separator System

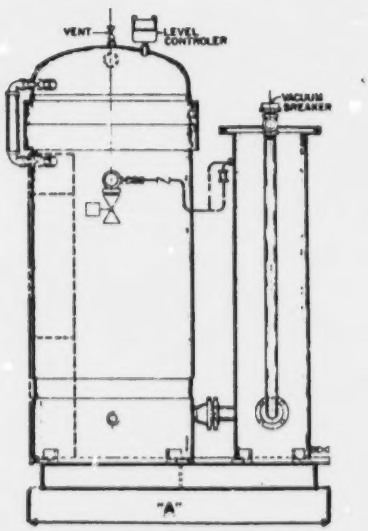
3-STAGE OIL-WATER SEPARATOR SYSTEM DIMENSIONAL DATA



PLAN VIEW



ELEVATION



END VIEW

MODEL NUMBER	FLOW RATE M³/H	FLOW RATE GPM	ASSEMBLED SYSTEM SIZE A in.	A cm.	B in.	B cm.	C in.	C cm.	SYSTEM PIPE CONNECTIONS INLET in.	INLET cm.	OUTLET in.	OUTLET cm.	OIL in.	OIL cm.	WATER in.	WATER cm.	SYSTEM PUMP HP
3OWS-0 5/2 2	.5	2 2	31	78.7	38¼	97.2	29	73.7	¾	1.9	½	1.3	1	2.5	½	1.3	½
3OWS-1/4 4	1.0	4 4	31½	80.0	45¼	114.9	55	139.7	¾	1.9	¾	1.9	1	2.5	¾	1.9	½
3OWS-2 8 8	2 0	8 8	34¾	88.3	51½	130.8	56	142.2	1½	3.8	1	2.5	1½	3.8	1	2.5	¾
3OWS-2 3/10	2.3	10 0	34¾	88.3	53½	135.9	57	144.8	1½	3.8	1	2.5	1½	3.8	1	2.5	¾
3OWS-3/13 2	3 0	13 2	36⅛	91.8	62¾	159.4	58	147.3	1½	3.8	1	2.5	1½	3.8	1	2.5	¾
3OWS-5 22	5.0	22 0	45	114.3	77½	196.9	73½	186.7	2	5.0	1½	3.8	2	5.0	1½	3.8	1
3OWS-5 7 25	5 7	25 0	45	114.3	77½	196.9	73½	186.7	2	5.0	1½	3.8	2	5.0	1½	3.8	1½
3OWS-10 44	10 0	44 0	55	139.7	87	221.0	82	208.3	3	7.6	2	5.0	2	5.0	2	5.0	3
3OWS-11 4/50	11.4	50 0	55	139.7	89	226.1	82	208.3	3	7.6	2	5.0	2	5.0	2	5.0	3
3OWS-22 8/100	22.8	100 0	73	185.4	109	276.9	106	269.2	3	7.6	2½	6.4	2½	6.4	2	5.0	5
3OWS-30 132	30	132 0	76½	194.3	112	284.5	106	269.2	3	7.6	2½	6.4	2½	6.4	2	5.0	7½
3OWS-45 6 200	45 6	200 0	82	208.3	138	350.5	133½	339.1	4	10.2	4	10.2	3	7.6	2	5.0	7½
3OWS-68 4 300	68 4	300 0	95	241.3	148	375.9	126	320.0	6	15.2	6	15.2	4	10.2	2	5.0	15
3OWS-91 2/400	91.2	400 0	114¼	290.2	158	401.3	123	312.4	8	20.3	6	15.2	5	12.7	2	5.0	25

NOTES
1 All dimensions shown are approximate. Certified dimensions are available upon receipt of an order.
2 Larger flow rates are available upon request

Facet

Industrial Division
Facet Enterprises, Inc.
P.O. Box 50096
Tulsa, Oklahoma 74150 U.S.A.
(918) 834-2929 Telex: 49-2495

Oil-Water Separator System

SI^N AND PERFORMANCE STANDARDS

Facet Oil-Water Separator System produces effluent water which fulfills stringent requirements of the following regu-ns nd agencies:

- Water Pollution Control Act 1972
- Clean Water Act 1977
- U.S. Coast Guard 46 CFR part 162.050
- I.M.O. (Intergovernmental Maritime Organization) A.393 (X)
- American Bureau of Shipping

QUALIFICATION FOR MARINE SERVICE

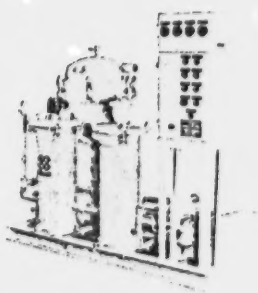
C AST GUARD & I.M.O. CERTIFIED

Both 10 & 100 gpm Facet Oil-Water Separators have undergone stringent testing by the National Sanitation foundation for certification to U.S.C.G. 46 CFR 162.050 in accordance with I.M.O. specification A.393 (X). The Facet systems successfully passed both the 15 ppm & 100 ppm tests while subjected to oil quantities up to 25%. The highest oil content in the effluent during 15 ppm test was 2.5 ppm.

The tests were conducted on a heavy fuel oil with a relative density .94 at 15°C and a light fuel oil with a relative density .83 at 15°C. Electrical components of the system were also subjected to vibration testing by an independent lab.

—U.S. COAST GUARD APPROVAL NUMBERS—

3 STAGE OIL—WATER SEPARTOR	15 PPM	100 PPM
3OWS-0.5/2.2	162.050/1022/0	162.050/1070/0
3OWS-1/4.4	162.050/1023/0	162.050/1071/0
3OWS-2/8.8	162.050/1024/0	NA
3OWS-2.3/10	162.050/1016/0	162.050/1072/0
3OWS-3/13.2	162.050/1025/0	162.050/1073/0
3OWS-5/22	162.050/1026/0	NA
3OWS-5.7/25	162.050/1027/0	162.050/1074/0
3OWS-7.5/33	NA	162.050/1075/0
3OWS-10/44	162.050/1028/0	162.050/1076/0
3OWS-11.4/50	162.050/1029/0	162.050/1077/0
3OWS-15/66	162.050/1030/0	162.050/1078/0
3OWS-22.7/77	162.050/1031/0	162.050/1079/0
3OWS-20/88	162.050/1032/0	162.050/1080/0
3OWS-22.7/100	162.050/1017/0	162.050/1081/0
3OWS-25/110	162.050/1033/0	NA
3OWS-27.5/121	162.050/1034/0	NA
3OWS-30/132	162.050/1035/0	NA



2-STAGE OIL—WATER SEPARATOR	15 PPM
2OWS-.25/1.1	162.050/1085/1
2OWS-.50/2.2	162.050/1086/1
2OWS-1/4.4	162.050/1087/1
2OWS-2/8.8	162.050/1084/1
2OWS-3/13.2	162.050/1088/1
2OWS-4/17.6	162.050/1089/1
2OWS-5/22	162.050/1090/1

MODEL LEGEND: 3 OWS - 2.3 / 10

- 10 U.S. GPM FLOW
- 2.3 M^3/H FLOW
- Oil-Water Separator
- Three Stage System

Distributed By:

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Industrial Division
Facet Enterprises, Inc.
P.O. Box 50096
Tulsa, Oklahoma 74150 U.S.A.
(918) 834-2929 Telex: 49-2495

Oil-Water Separator System

OIL-WATER SEPARATOR APPLICATION INFORMATION

1. **APPLICATION** (General Description): _____

_____

2. **OPERATING CONDITIONS AT POINT OF INSTALLATION:**

   A. TYPE(S) OF OIL: _____

   B. VISCOSITY OF OIL: _____ SSU CS CP @ _____ °F. SPECIFIC GRAVITY _____ @ _____ °F.

   C. MAXIMUM AMOUNT OF OIL IN WATER: _____ PPM

   D. TWO MINUTE SEPARABILITY: (Fill a one-quart jar with oily-water mixture, shake vigorously for 30 seconds. Allow to stand for two minutes.)

      (1) OIL LAYER PRESENT AFTER TWO MINUTES ☐ YES ☐ NO

      (2) WATER LAYER AFTER TWO MINUTES ☐ CLEAN ☐ CLOUDY ☐ MILKY

   E. FLOW RATE: _____ US GPM TEMPERATURE: _____ °F.

   F. TOTAL FLOW RATE PER 24-HOUR DAY _____ US GPM

   G. FLOW RATE IS: ☐ CONTINUOUS ☐ INTERMITTENT

   H. DESCRIPTION OF SOLID CONTAMINANTS: _____

   I. AMOUNT OF SOLIDS: _____ (PPM) (% VOL.)

   J. PARTICLE SIZE DISTRIBUTION: % _____ 0-5 MICRONS % _____ 5-25 MICRONS

      % _____ 25-100 MICRONS % _____ OVER 100 MICRONS

   K. DESCRIPTION OF WATER: _____

   _____

   L. pH of OIL: _____ OF WATER: _____

   M. HOLDING TANK, IF RECOMMENDED, WOULD BE ACCEPTABLE: ☐ YES ☐ NO

   N. WORKING PRESSURE: _____ PSI

   O. POWER AVAILABLE FOR PRIME MOVER:

      ☐ ELECTRICAL: _____ VOLTAGE _____ WATTAGE _____ PHASE

      ☐ AIR: _____ CFM _____ PSI

   P. SPECIAL REQUIREMENTS: _____

   _____

   _____

3. **REQUIRED PERFORMANCE:**

   A. DESIRED SOLIDS REMOVAL: _____ (MICRON) (PPM)

   B. DESIRED WATER PURITY: _____ PPM OIL

   C. WATER TO BE REUSED: ☐ YES ☐ NO

   D. OIL TO BE REUSED: ☐ YES ☐ NO

   E. OTHER INFORMATION: _____

   _____

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(918) 834-2929 Telex: 49-2495

Oil-Water Separator System

OIL-WATER SEPARATOR APPLICATION INFORMATION

4. **DESIGN CONDITIONS:**

   A. DESIGN PRESSURE _____ PSIG

   B. DESIGN TEMPERATURE: _____ °F.

   C. CORROSION ALLOWANCE: _____

   D. CODE OR SPECIFICATION: ASME _____ ASME STAMP _____ COMM. STD. _____ OTHER _____

   E. FLOW RATE _____ US GPM _____

   F. MATERIALS OF CONSTRUCTION: _____

   G. MAXIMUM SIZE OF SKID PLATFORM: _____

   _____

   _____

5. **ACCESSORIES:**

   A. POLISHING STAGE BYPASS LINE ☐ YES ☐ NO

   B. EFFLUENT DIVERSION VALVES ☐ YES ☐ NO

   C. OIL CONTENT MONITOR ☐ YES ☐ NO

SPECIAL CAUTIONS:

A. DESIGNS WILL BE MADE ON THE BASIS OF THE DATA SHOWN HEREIN. IF FACET ENTERPRISES, INC. SHOULD ANALYZE SAMPLES, THE DESIGN WILL BE BASED ON THE FINDINGS AND REPORTING OF THE ANALYSIS AND AS SUCH, ALL DESIGN AND PERFORMANCE WILL BE BASED ON EITHER OR BOTH DATA PARAMETERS.

B. WE RECOMMEND SYSTEMS BE EQUIPPED WITH CONTROLS BECAUSE OF THE DIFFICULTY IN PRODUCING THE DESIRED EFFLUENT QUALITY WITHOUT MAINTAINING PROPER OIL/WATER INTERFACE LEVELS.

SUBMITTED BY: FOR:

_____ _____

_____ _____

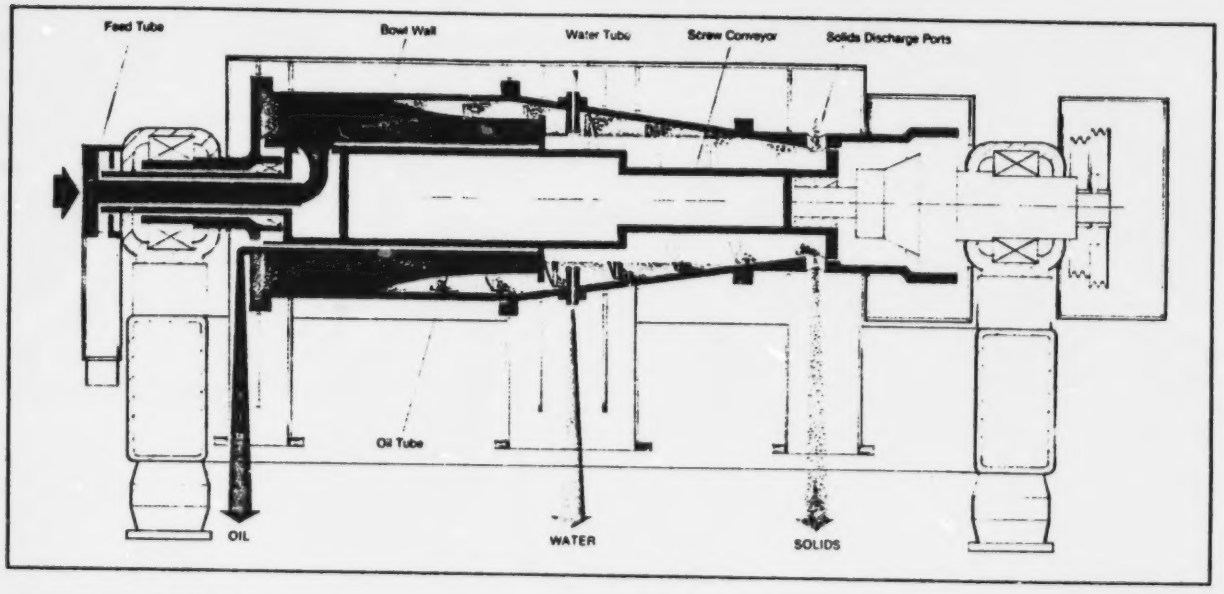
_____ _____

ALL SAMPLES MUST BE CLEARLY MARKED INDICATING CONTENTS.

MAIL SAMPLE TO: **Industrial Division**
Facet Enterprises, Inc.
2929 East Apache
Tulsa, Oklahoma 74110
Attn.: Laboratory Manager
Engineering Building

lletin 5.1.6[illegible] Attachment — Copyright — Facet Enterprises, Inc. — December 1982 — Printed in U.S.A.

The Humboldt 3-Phase Decanter Centrifuge
A Reliable New Processing Tool



How Does it Work?

The Humboldt 3-Phase Decanter is specially designed to give efficient sedimentation of solids, coupled with separation of two liquid phases ☐ The feed mixture enters the rotating bowl through a stationary feed tube and is thrown outwards against the bowl wall ☐ The centrifugal force generated by the rotation rapidly sediments the solid particles against the bowl wall where they are moved by a helical screw conveyor towards the solids discharge ports ☐ As the clarified liquid flows along the bowl, the centrifugal force causes oil and water to separate; the water moving outwards and the oil towards the axis of the bowl ☐ A weir within the bowl divides the oil and water, which then flow through individual tubes and discharge into collecting chutes outside the bowl ☐ According to the relative densities of the oil and water phases and the required process result, the levels of oil and water within the bowl are independently adjustable. ☐ Humboldt's special internal design gives accurate control of the oil/water interface, ensuring stable operation, even with widely fluctuating feed concentrations ☐

Mechanical Features

☐ Corrosion resistance — selected to suit your process — materials available include high-tensile carbon steel, stainless steel, Incolloy, Hastelloy, Nickel, Titanium etc.
☐ High Temperature operation — standard models suitable for temperatures up to 110°C.
☐ Wear Protection — high quality hardsurfacing on parts subject to abrasive wear.
☐ Gas-tight construction — available for explosive environments.

Proven Co-current Design

The 3-Phase Decanter incorporates all the features of the highly successful Humboldt co-current sludge centrifuge.
☐ Efficient clarification at low speeds
☐ Minimal power use
☐ Quiet operation
☐ Low abrasive wear
☐ Robust construction
☐ Mechanical reliability
Humboldt co-current decanters are operating worldwide in hundreds of different applications

Humboldt 3-Phase Decanters

Model No.	Bowl Dimensions (mmØ/mm Length)	Motor (kw)	Capacity* (m^3/h)
S0-1 3P	250 / 750	7.5	1-2
S1-1 3P	350 / 950	11	2-5
S2-1 3P	450 / 1350	15	4-10
S3-0 3P	520 / 1560	18.5	6-15
S3-2 3P	600 / 1800	37	10-25
S4-1 3P	900 / 2500	56	20-40
S5-1 3P	1100 / 3300	75	40-80

* Capacity figures are guidelines only — Consult Humboldt Wedag for detailed recommendations

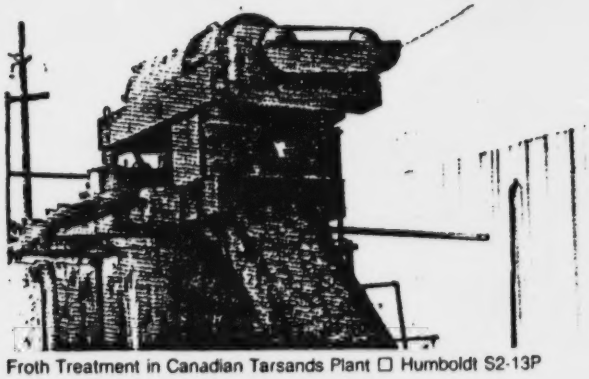
Other Humboldt Decanters are available for most solid-liquid separations

KHD Humboldt Wedag AG

Postf. 91 04 04, D-5000 Koln 91, Tel. (02 21) 823-1, Telex 8 812 267
Postf. 10 27 30, D-4630 Bochum 1, Tel. (02 34) 539-1, Telex 8 25 894
Federal Republic of Germany

Humboldt 3-Phase Decanter Centrifuges — for Efficient Oil and Fat Processing

Fat Recovery from Slaughter House Wastewater ☐ Humboldt S1-13P



Froth Treatment in Canadian Tarsands Plant ☐ Humboldt S2-13P

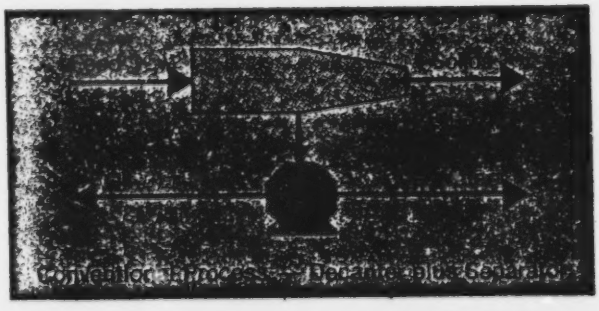
How Is it Used?

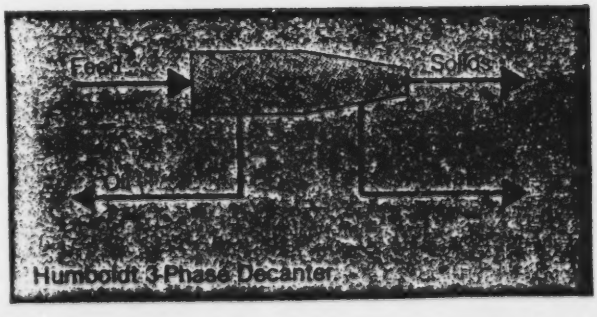
In oil and fat processing, decanter centrifuges are commonly used to remove solids such as grit, bone, fibre, protein and carbohydrate before separating water in settling tanks or separator centrifuges.

The Humboldt 3-Phase Decanter separates solids, water and oil in one simple, continuous operation.

Its many applications include

- ☐ Wet rendered offal
- ☐ Low-temperature fat rendering
- ☐ Dry rendered tallow polishing
- ☐ Reclaim fat from wastewater
- ☐ Poultry fat and meal
- ☐ Cooked fish and fishmeal press liquor
- ☐ Vegetable oils
- ☐ Palm oil and Olive oil
- ☐ Waste lubricating oil
- ☐ Tarsands (Froth Treatment)
- ☐ Shale oil recovery





How Will it Cut Costs?

Where a solid-bowl centrifuge is needed to clarify oil/water mixtures before separation, the Humboldt 3-Phase Decanter will do this and will also:

Eliminate Separators — in many applications the 3-Phase Decanter produces very pure oil and water phases, making expensive, high-speed disc separators unnecessary.

Reduce Emulsification — ordinary Solid-bowl decanters often emulsify oil and water on discharge from the bowl. By separately discharging relatively pure oil and water the 3-Phase Decanter avoids this emulsification. This makes subsequent separation or polishing much easier.

Increase Oil Recovery — the special Humboldt design minimises oil loss in the solids cake, thus improving overall recoveries.

Handle Difficult Solids — large clearances and high solids capacity enable the 3-Phase Decanter to process materials which would cause troublesome blockages in disc centrifuges.

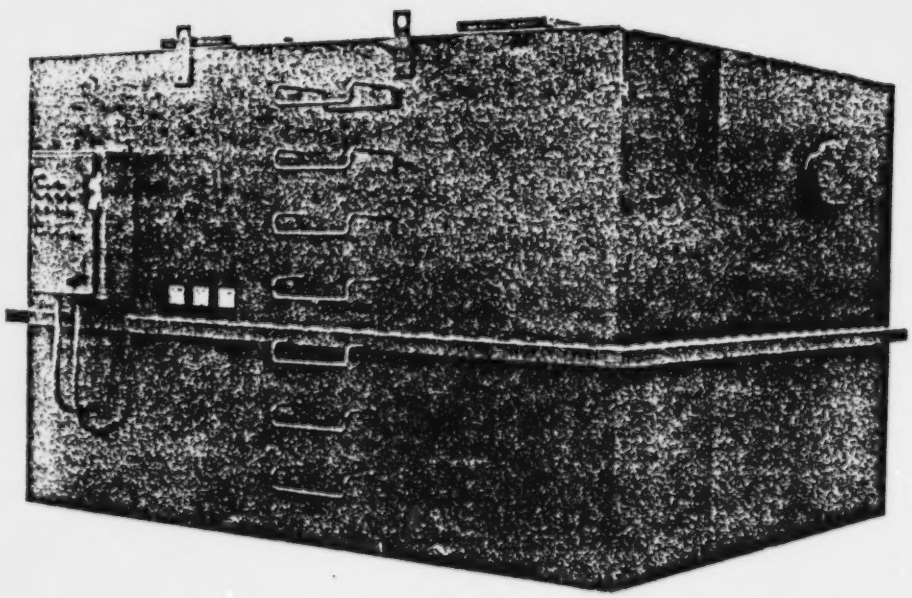
Provide Versatility — for semibatch or multiple processes the Humboldt 3-Phase Decanter requires no adjustment to operate as a standard solid-bowl decanter.

Simplify Process Design — less complicated plant saves space and reduces capital and operating costs.

HUMBOLDT WEDAG

Facet Model 2000

Dual Mode Gravity and Coalescing Separator System



Facet

Facet Model 2000

Dual Mode Gravity and Coalescing Separator System

Selecting and specifying wastewater treatment equipment is no easy task. Conditions in the waste stream vary much more than those typically found in other process areas. Wastewater equipment design must encompass a wide range of operating conditions.

Facet's Model 2000 removes free, dispersed, and mechanically emulsified oils from water. The design of the Facet system takes into consideration these varying treatment requirements:

- Variations in type of oil, specific gravity, and viscosity.
- Proportion of free oil.
- Proportion of emulsified oil.
- Variations in flow rate from 0 to rated flow.
- Intermittent flows.
- Variation in temperature.
- Oil surges and spills.
- Quantities of solids.
- Proportion of suspended and settleable solids.
- Particle size distribution of solids.
- Other contaminants.

Operation

Dual Mode—The system may be operated as either an A.P.I. type gravity separator or as a coalescing separator for removal of emulsified oil droplets. The Dual Mode Gravity and Coalescing Separator has four stages of separation. Water enters the separator and is directed downward at a velocity of 40 feet per minute or less. The water then makes a direction change which causes grit, sand and other settleable solids to fall out. Water and oil pass up through the Mechanical Pak. The Pak is a steel cage containing media which is oleophilic (oil loving) and hydrophobic (water repellent). The Pak reaches the full width of the separator and distributes the water to achieve laminar flow. The Pak also coalesces oil droplets similar to the operation of a coalescing cartridge. Coalescing oil droplets remain attached to the media until they are large enough to freely float. Breaking free, they rise to the top of the compartment. The remaining oil and water pass through the primary separation compartment where the velocity is sufficiently slowed to allow entrained oil droplets to separate.

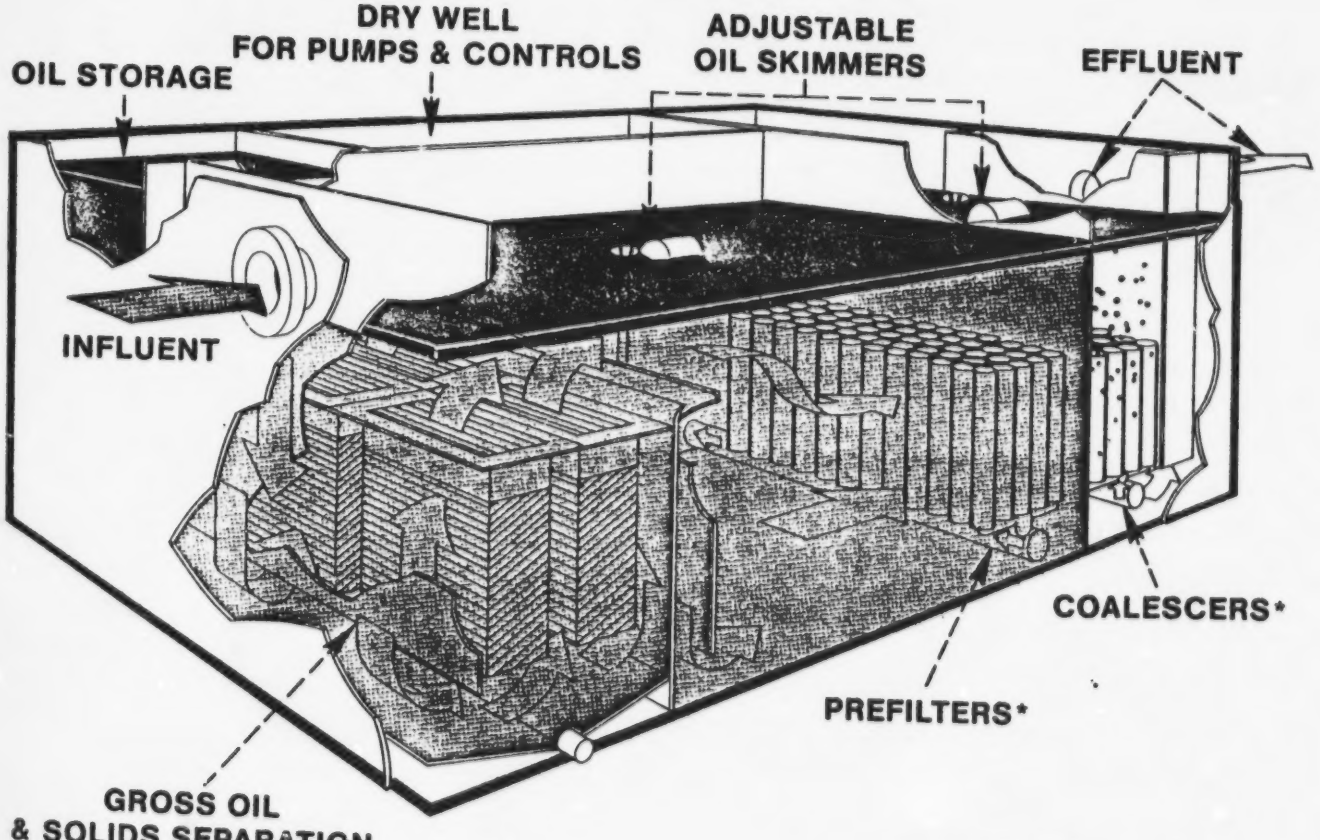
If the emulsified oil content is low, the water can be allowed to gravity flow through the ByPass Gate. The water pump and coalescer cartridges can be locked out by a switch on the control panel.

During periods when emulsified oil content is high, the Gravity ByPass Gate is closed and the water pump is activated to draw water through a bank of prefilter and coalescer cartridges. Emulsified oils are coalesced and the oil droplets rise to the top of the secondary separation compartment. Water flows out of the separator by gravity.

The water pump operation is controlled by level switches in both the primary and secondary separation compartments. Intermittent and varying flows from zero to full ratings are handled by the standard unit. A minimum cycle time of three minutes is maintained for the pump.

Stationary oil skimmers in each separator compartment remove oil by gravity to the oil skimmer sump. Interface detectors control the oil removal rate and maintain a continuous oil layer on the water surface. The level in the sump is controlled automatically by high and low level control switches. An integral oil transfer pump can be used to transfer oil between the skimmer sump and a built-in oil storage compartment and also between the sump and remote storage or disposal facilities.

Facet Model 2000



*PUMPED FLOW ONLY

Facet Model 2000

Dual Mode Gravity and Coalescing Separator System

Performance

Th. system is designed to meet the 10 ppm oil discharge limit established by he Federal Water Pollution Control Act f 72.

Alternate limits such as 25 or 50 ppm ar be met by operating in the gravity go or by selecting other Facet artridges. SOLIDS FLO-THRU™ car-idges pass solids up to 100 micro-e s while retaining and coalescing il.

Installation

ac 's Model 2000 can be shipped by mmon carrier. Lifting lugs are pro-ded for ease of handling. The system n be installed inside or outside, o. or below ground. Below ground its have a dry well for pumps and n ls. The system can be installed c ncrete sump or backfilled with a sized gravel or sand. Complete eration manuals are provided cover-g oper installation, operation and ainenance.

Applications

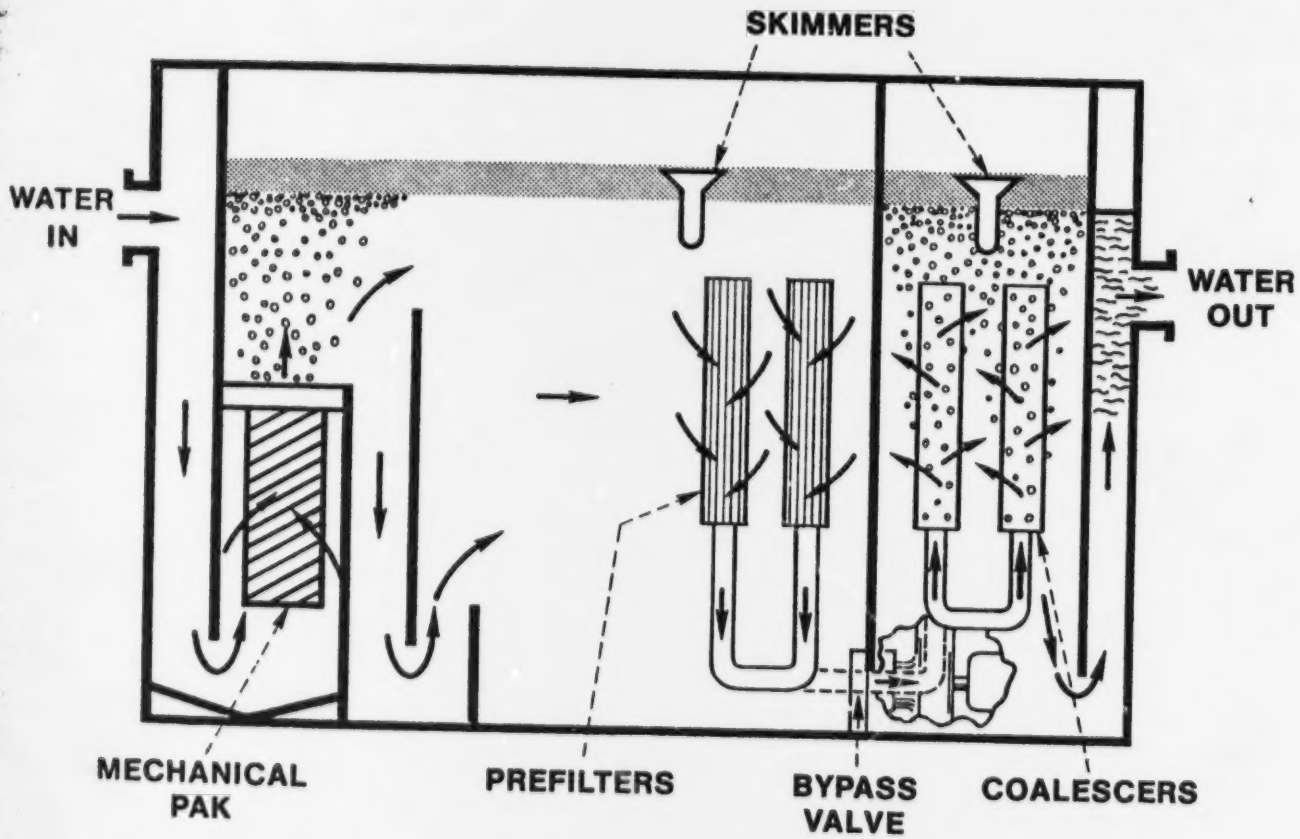
- Major Oil Spills
- Oil Field Production
- Land Based Bilge and Ballast Water
- Refineries
- Petrochemical Plants
- Steel Mills
- Railroad Yards
- Commercial Liquid Waste Disposal Facilities
- Chemical Plants
- Truck Loading Terminals
- Power Plants
- Fleet Maintenance Terminals
- Commercial Marine Ports
- Airports
- Transformer Parks
- Tank Farms
- Manufacturing Plants
- Machine Shops

Features

- Proven performance in many different field applications.
- System requires no chemicals, recovered oil contains no contaminating emulsion breakers.
- Low operating cost.
- Dual Mode feature assures good performance.
- Performance is not effected by low or intermittent flow.
- Meets tomorrow's discharge requirements today without the need to invest in additional equipment later.
- Free laboratory service.
- Consistent operating performance.
- Recovers good quality oil. Typically contains less than 0.5% water.
- Requires less space than other systems.
- Easy installation.
- Automatic system for oil skimming and built-in oil storage.
- Completely assembled system with code quality carbon steel, grit blasted and coated with epoxy for corrosion resistance.
- Flow rates from 60 to 1500 GPM.

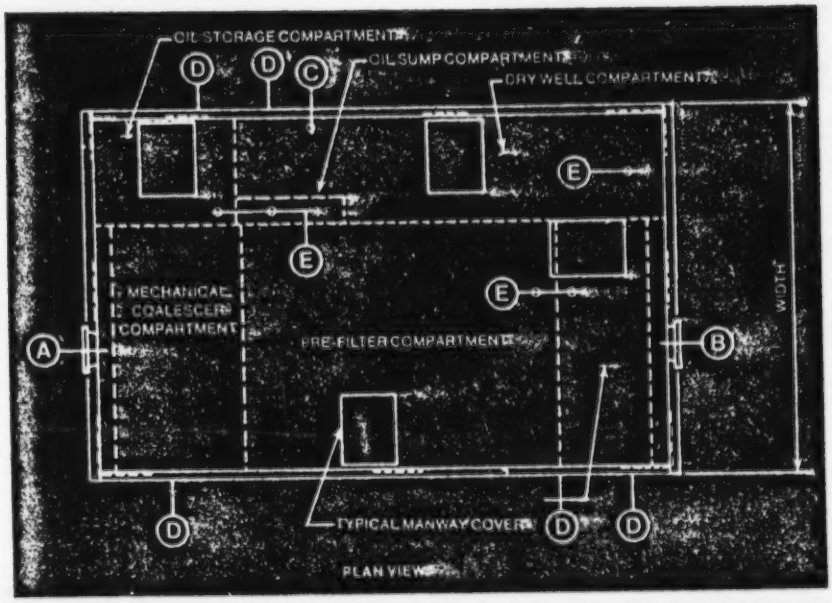
Facet Model 2000

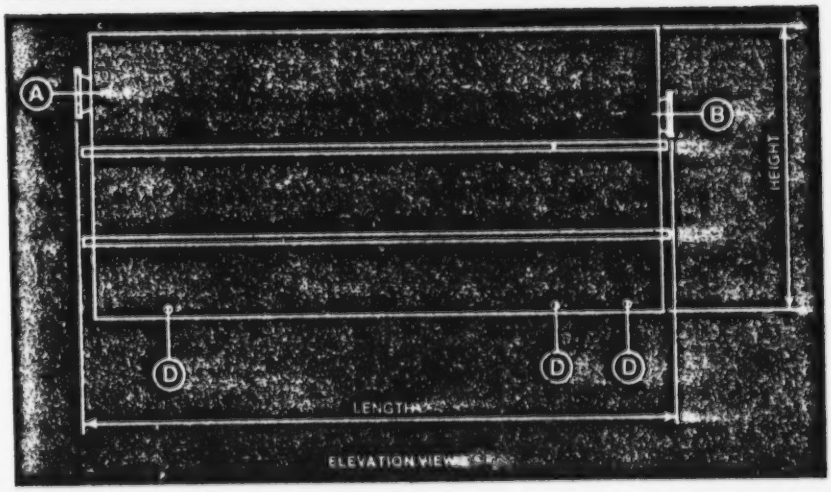
Flow Diagram



cet Model 2000

lode Gravity and Coalescing Separator System





T All dimensions shown are approximate. Certified dimensional drawings will be issued upon receipt of a purchase order.

	ormal pacity	Dimensions												Approx. Shipping Weight
P∞	B/D	Width	Length	Height	Inlet A	Outlet B	Oil Disch. C	Drain D	Vent E	Rated HP Filter Pump	Rated HP Oil Pump	Oil Storage Capacity Gallons (Approx.)	Oil Spill Contain. Capacity Gallons (Approx.)	
100	3,428	6'-6"	10'-7"	8'-0"	6"	6"	1"	2"	1/2"	5	3/4	300	1200	6600
2!	8,571	10'-6"	12'-8"	8'-0"	8"	8"	1-1/2"	2"	1/2"	7-1/2	1-1/2	700	2500	13300
500	17,142	10'-6"	16'-8"	8'-0"	10"	10"	1-1/2"	2"	1/2"	15	1-1/2	700	5000	16800
7	25,714	10'-6"	23'-10"	9'-0"	12"	12"	1-1/2"	2"	1/2"	20	1-1/2	1400	8500	24500
0	34,285	12'-6"	24'-4"	10'-0"	14"	14"	1'-1/2"	2"	1/2"	25	1-1/2	2000	10000	32200
500	51,428	12'-6"	36'-11"	10'-0"	16"	16"	1-1/2"	2"	1/2"	40	1-1/2	2000	12500	41100

Facet Model 2000

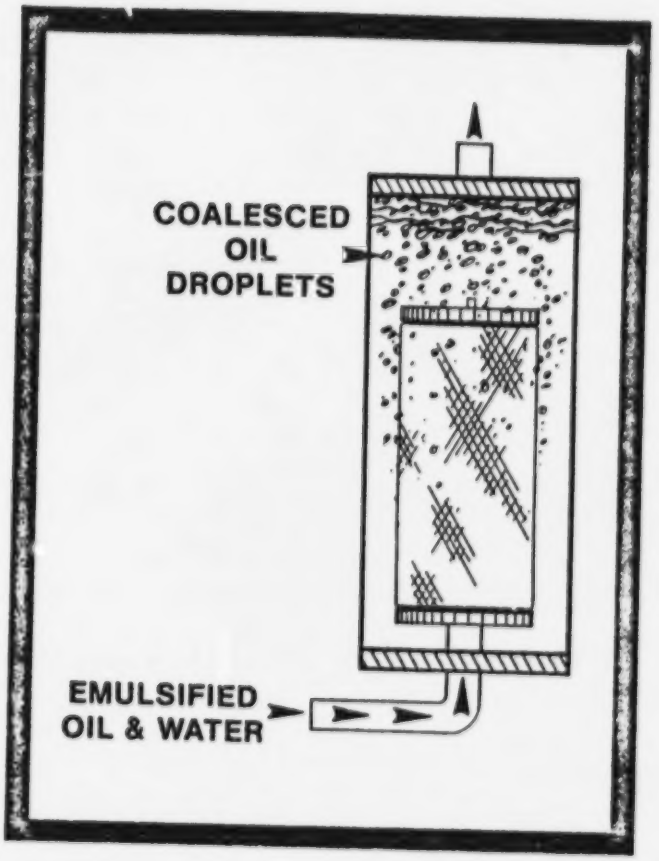
Todays Discharge Standards Demand Coalescing Technology

The Federal Water Pollution Control Act of 1972 established a 10 ppm limit for oil discharged in wastewaters to navigable streams. Many local regulatory agencies subsequently adopted tough standards for water discharged to sewers and local waters.

Almost all oil/water mixtures contain some emulsified oil. Emulsions of oil-in-water are caused by vigorous mechanical actions such as pumping, heavy rainfall, shear, spray washing and other physical actions whereby the oil is physically broken into minute droplets. Chemically formed or stabilized emulsions are created by the addition of emulsifiers or detergents and require chemical injection just upstream of the coalescing separators.

Emulsified oil is becoming an increasingly difficult problem. Standard API and gravity separators won't meet the requirements for emulsified oil separation. Only free-oil is removed by gravity separators which, in many instances, is just a partial solution to the problem of meeting today's regulatory standards.

Facet's Model 2000 Dual Mode Gravity and Coalescing Separator system will remove both free and emulsified oils.



Note:
Due to our continuing program of product improvement, specifications are subject to change without notice.

Facet

Industrial Filter Products
Facet Enterprises, Inc.
P.O. Box 50096
Tulsa, Oklahoma 74150
(918) 939-5451 Telex: 49-2495

Facet Industrial Filter Products & Services

Products

- Activated Carbon Filters
- Basket Strainers
- Breather Filters
- Coalescers and Strainers
- Combination Go-No-Go® Gage/Filter Water Separators
- Compressed Air or Gas Filter Coalescers
- Continuous Ion eXchange (CIX)
- Differential Pressure Indicators
- Fluid Analyzers
- Fluid Reconditioners
- Fluid Systems Filtration
- Fluidizing Media
- Fuel Contaminant Monitors
- Fuel Handling Filtration Systems
- Fuller's Earth Filters
- Hydraulic Filters
- Liquid/Liquid Filtration and Separation
- Lubricants and Greases
- Noise Suppression Media
- Oily-Water Systems
- Polymer Filters and Valves
- Porous Metal Products
- Solids/Liquid Filtration
- Stack Monitoring Filtration
- Vessels
- Wastewater Treatment Systems

Services

- Electron Beam Welding
- Filter Performance Testing

Environmental Regional Offices

Warwick, Rhode Island
(401) 467-2450

Tulsa, Oklahoma
(918) 939-5451

Products of Facet Divisions & Subsidiaries

Industrial Filter Products
Tulsa, Oklahoma
Industrial filters and separator filters for broad industrial and process application, oil from water separation and environmental systems to treat industrial wastes.

Filter Products Division
Madison Heights, Michigan
Precision porous media and filters for aircraft and chemical processing; also filters for hydraulic systems, filtration, separation and monitors for fuel handling.

Automotive Components Operations
Elmira, New York
Starter drives, fuel pumps, electromagnetic clutches and electronic relays for industrial agricultural and automotive uses.

Fuel Devices Division
Detroit, Michigan
Carburetors, fuel filters for farm equipment and lift trucks, as well as fuel filters and flame arresters for inboard marine engines.

General Products Division
Henderson, North Carolina
Environmental control system filters for home and industry. Panel, bag and pleated filters, fiberglass rolls and pads, and absolute air filters.

P & D Automotive Division
Jackson, Tennessee
Electric fuel pumps and starter drives, electronic ignition devices, tune-up products and chemicals for the automotive aftermarket.

Campbell Filter Company
Tulsa, Oklahoma
Automotive oil, air and gasoline filters for the tire and rubber industry, the oil industry, automotive distributors and retail mass merchandisers.

Facet distributors are listed in the Yellow Pages under "Filters, Liquid."

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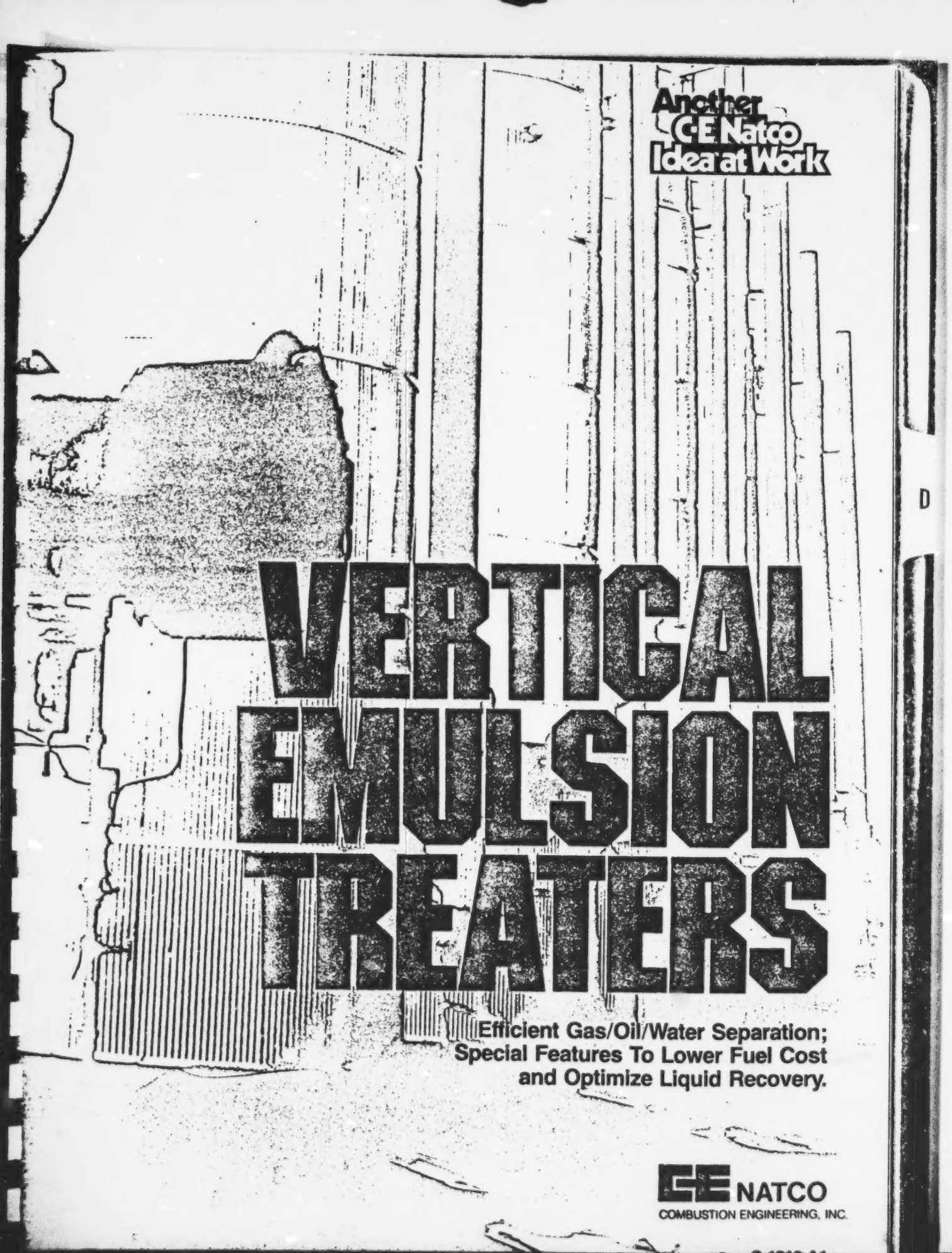

Another
C-E Natco
Idea at Work
VERTICAL
EMULSION
TREATERS
Efficient Gas/Oil/Water Separation;
Special Features To Lower Fuel Cost
and Optimize Liquid Recovery.
NATCO
COMBUSTION ENGINEERING, INC.

DEGASING, HEATING AND DEHYDRATION IN ONE EFFICIENT SYSTEM

An optimum system for dehydrating crude oil emulsions can require one or any combination of numerous processes: preheating, degassing, free water removal, heating, chemical additives, and coalescing.

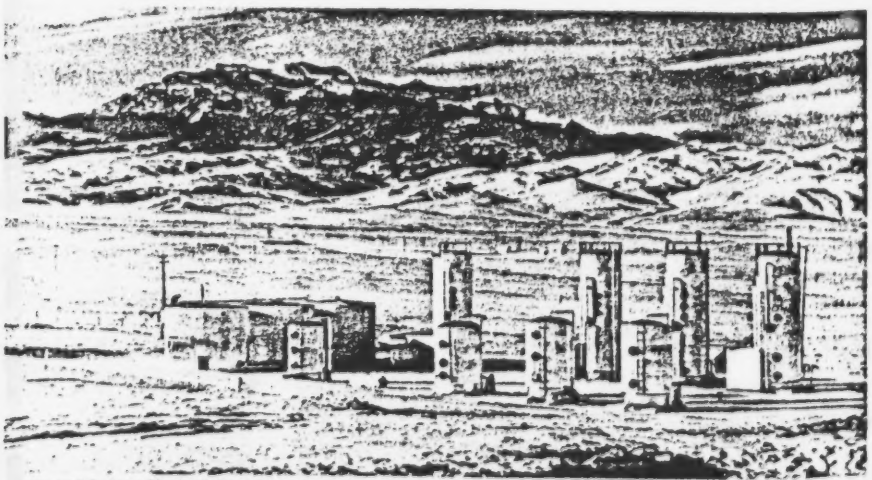
C-E Natco Vertical Emulsion Treaters are designed to use any combination of these functions, as your particular application requires. In addition, special features and options can extend a treater's versatility and enhance its efficiency.

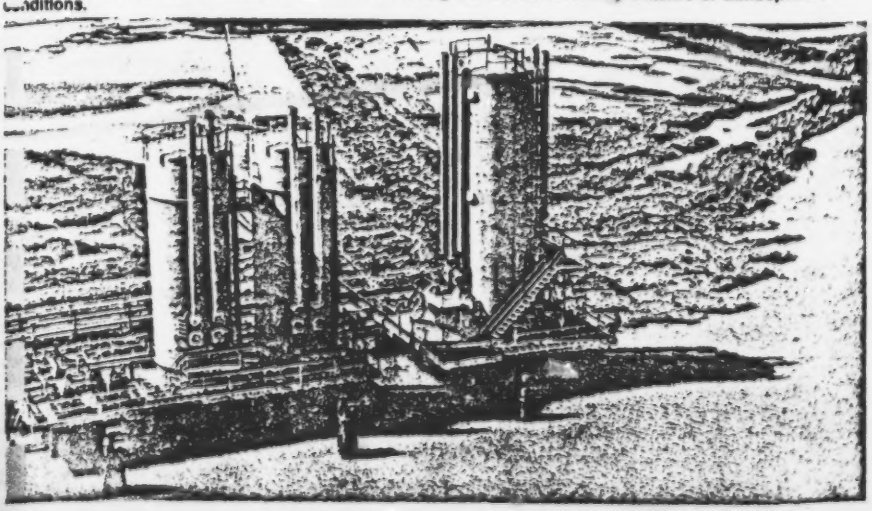
Vertical Treaters are primarily applicable to low volume flows, with high water content.

Numerous design features contribute to the system's notable operating economy, and optimum recovery of condensable, salable hydrocarbons. These features include:

- A reversible firetube which provides long life and the proper heat for controlled separation.
- Crossflow heat-retention baffles.
- A condensing head which minimizes vapor loss of hydrocarbons.
- Corrosion-resistant adjustable fiberglass siphon nipples.

The basic vertical treater design has the flexibility to allow modification to meet a specific set of separation requirements. For instance, cone-shaped desanding units, designed for either automatic or manual operation, are available.





Above and below, Vertical Emulsion Treaters are designed and built for any climatic or atmospheric conditions.

THE PROCESS
Continuous-flow separation

The inflowing wellstream separates into gas and liquid. Gas is drawn off the top of the vessel, while liquids flow through a downcomer below the firetube. Specially designed baffles direct the heavier free-water downward, and the lighter oil/water emulsion upward.

The emulsion rises past the firetube, absorbing heat. Heat and the scrubbing action of the baffle trays break the emulsion as it passes through the vessel.

Separated water drops collect and coalesce on a fibrous medium, then settle to the bottom while oil continues rising.

Water is removed from the bottom of the treater through a valve-monitored siphon; oil is removed at the top through a spillover box and control valve. The desired oil/water level can be maintained from the outside by adjusting the siphon nipple.

Working Pressures

Standard systems perform from atmospheric pressure to 50 psi; special systems to 100+ psi.

OPTIONS
Higher-efficiency heating, fuel savings

An external heat exchanger preheats inlet fluid for more economical treating. It also cools outgoing treated oil to the desired storage tank temperature, preventing vaporization and loss of valuable hydrocarbons. The result is reduced fuel consumption and increased oil volume to sales.

C-E Natco's Combustion Air Controller governs air flow into the burner system. The result is optimum air/fuel ratio throughout the firing range; hence, improved energy efficiency.

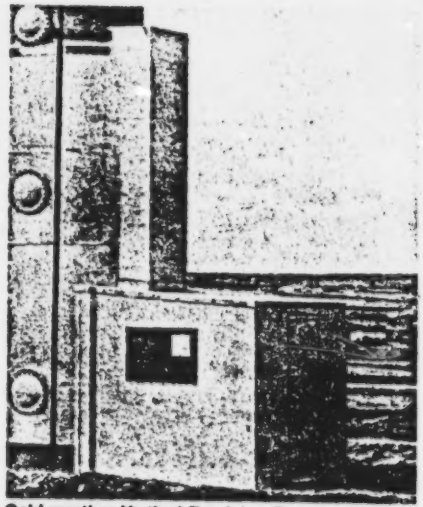
A Turbulator installed in the firetube exhaust chamber provides additional economy by reducing heat loss out the stack. Since heat is transferred to the fluid more efficiently, fuel consumption is reduced as the heater firing is optimized. Additional benefits: reduced thermal stresses, longer heater life with less repair.

Optional features

- Alternate heat sources: oil burners, hot oil bundles, steam bundles, electric heating elements
- Flame arrestor
- Automatic ignition
- Flame safety shutdown
- External heat exchanger
- Safety fuel gas scrubber
- Lever or pneumatically operated controls
- Pilot or lever-operated gas back-pressure valves
- Access ladders
- Top-mounted platform with safety rails
- OCF (oil-covered firetube) baffles
- Defoaming cascade trays
- Internal preheater
- Cold weather configuration with housed lines and valves or internal piping
- Full-size gas scrubber elements
- Insulation
- Fiberglass baffles for uncoated treaters

STANDARD VERSIONS Meet different production and climatic conditions

Systems in all four series below include heat baffle, outside siphon assembly with fiberglass nipple, 2" standard valves, and gas-burning equipment. Sizes range from 4' OD x 20' to 10' OD x 27½'; working pressures, 40 to 50 psig. Each is capable of handling medium to high gravity crudes.



Cold weather Vertical Emulsion Treater with insulated housing.

Series W-1: Warm weather, no excelsior section, one manway.

Series W-2: Large water volumes, warm weather, single excelsior section, two manways.

Series C-1: Large water volumes, warm weather, multiple excelsior sections, three manways.

Series W-4 and W-5: Large water volumes, warm or cold weather, single excelsior section in W-5, two manways, adjustable fiberglass nipple.

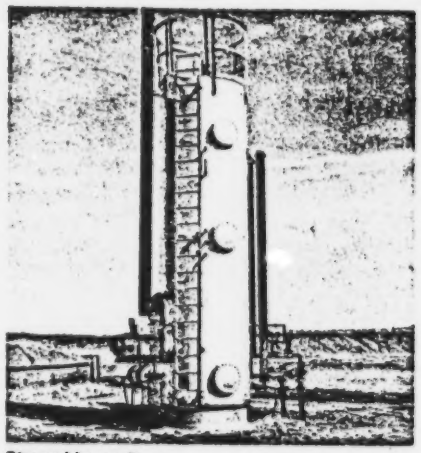
Cold weather applications require the addition of an inlet/outlet piping cover and valve housing. Upon request, units also are available with internal piping.

STREAMLINE™ UNITS Reduce capital investment

C-E Natco Vertical Emulsion Treaters are available in a StreamLine configuration, with a simplified design which reduces construction costs but maintains optimum liquid recovery efficiency.

StreamLine units operate economically even in rugged cold weather situations. Components are arranged for easy access, thereby reducing maintenance costs. Piping is external, and insulated by a protective housing.

StreamLine units and components are readily available from inventory at selected field operations.



StreamLine unit.

FOR MORE INFORMATION

For quotations or more information, contact C-E Natco:

Headquarters:
P. O. Box 1710, Tulsa, Oklahoma 74101 U.S.A. Telephone 918/663-9100 • Telex 49-2427 • Cable "Natco Tulsa".

U.S.A. Operations:
Regional offices in Bakersfield, California; Denver, Colorado; Harvey, Louisiana; Dallas and Houston, Texas. Over 50 sales/service locations.

Worldwide Operations:

Canada:
C-E Natco Limited; Calgary, Alberta.

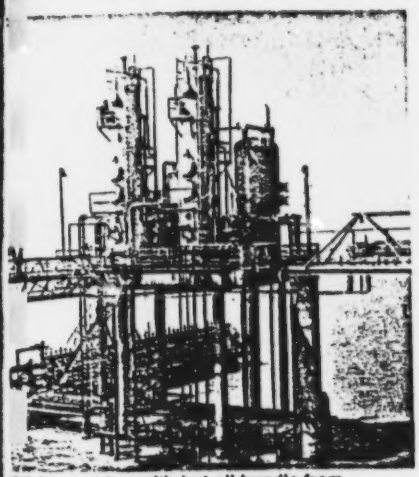
Europe:
Natco U.K. Limited; London • C-E Natco France; Paris • C-E Natco Netherlands, B.V.; The Hague.

Southeast Asia:
C-E Natco International, Limited; Singapore.

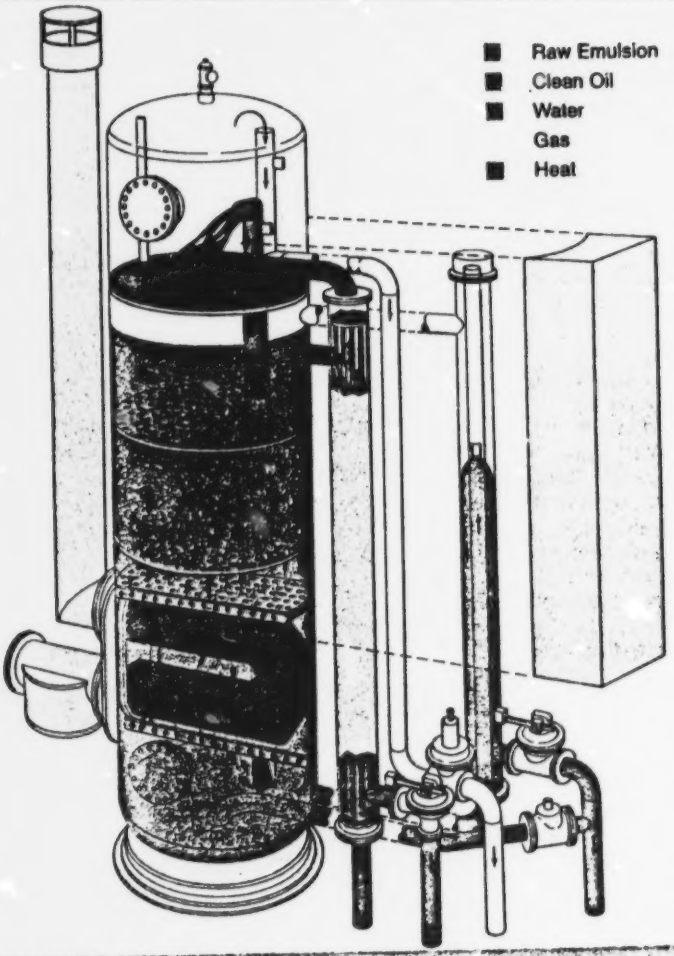
Latin America:
Headquarters — 16800 Greenspoint Park Drive Suite 250 -- North Atrium, Houston, TX 77060 U.S.A. Telephone 713/820-4800 • Telex 791937

Special Products Division
More than 25 U.S. representatives, coast-to-coast. Contact Manager — Special Products Division, C-E Natco headquarters, for the representative nearest you.

NATCO
COMBUSTION ENGINEERING, INC.



Offshore system with hot oil bundle from joining platform.



MORE BENEFITS AND OPTIONS

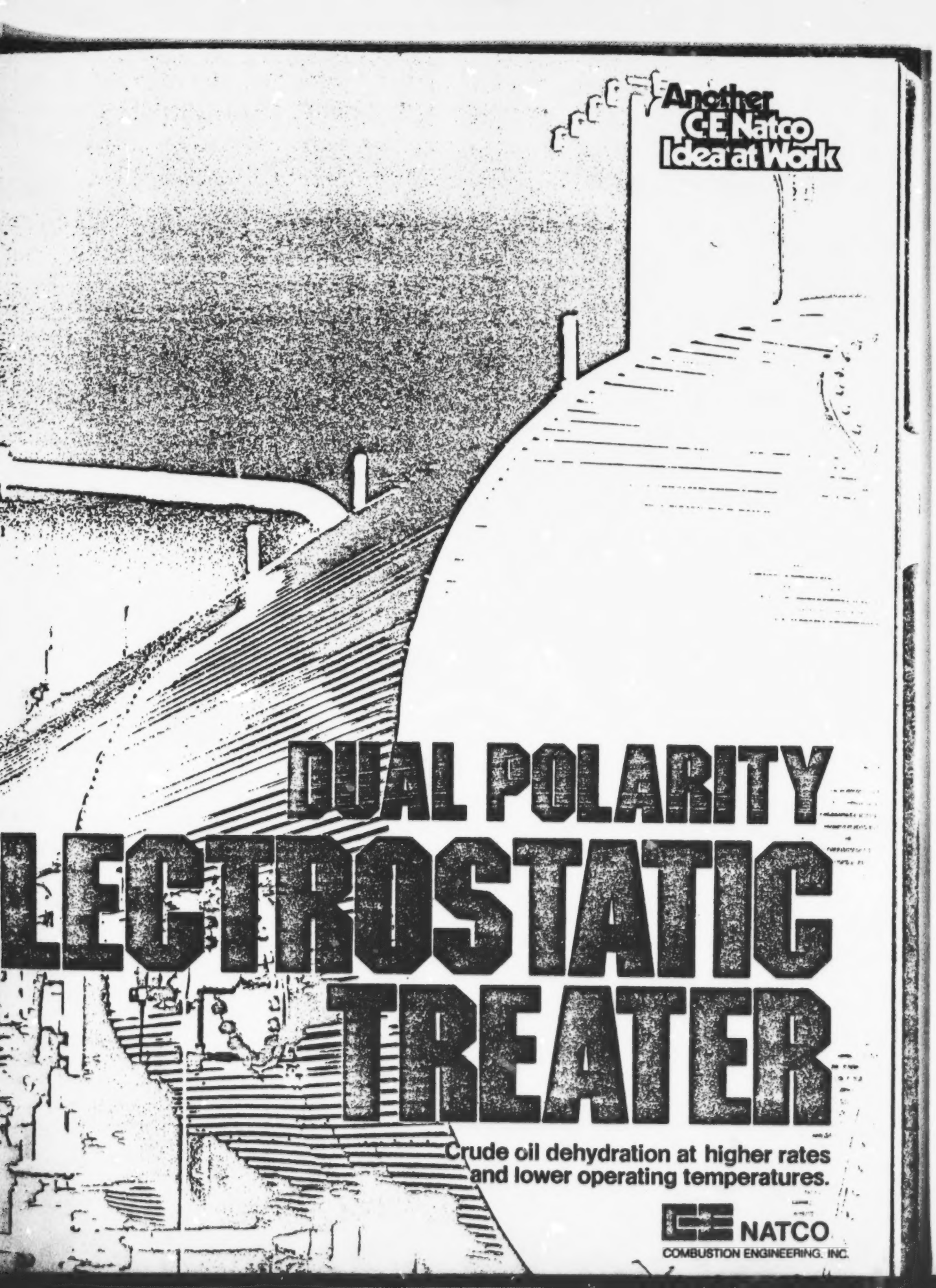
Standard features

- Automatically controlled gas burning equipment with manual shutoff
  Single or multiple excelsior sections
  Oil and water control valves
- Pressure gauge
- Gauge glasses with safety gauge cocks
  Thermostat and thermometer
- Pipe bracing
- One year warranty
  Fiberglass baffles for internal-coated treaters

VERTICAL EMULSION TREATER CAPACITIES

DESCRIPTION		Shell O.D.	Standard Working Pressure (PSI)	Standard Btu/hr. Use Rate	Capacity* 20' Shell Height Oil (Bbls/day)	20' Shell Height Water (Bbls/Day)	27½' Shell Height Oil (Bbls/Day)	27½' Shell Height Water (Bbls/Day)
Warm Weather Series		4'	50	350 M	96- 360	200- 600	120- 480	250- 1800
20° to 42° to high gravity crude oils. Removeable heat baffle, no excelsior section, outside siphon assembly, one manway.	W-1	6'	50	500 M	192- 480	400-1300	240- 840	550- 4000
		8'	40	1000 M	360- 960	800-2200	480-1920	1000- 7000
		10'	40	1350 M	480-1200	1000-3500	600-2880	1500-10000
Similar to W-1 but with one excelsior section and two manways		4'	50	350 M	120- 600	200- 600	150- 648	250- 1800
		6'	50	500 M	192- 840	400-1300	240- 960	550- 4000
	W-2	8'	40	1000 M	360-1680	800-2200	480-2160	1000- 7000
		10'	40	1350 M	480-2160	1000-3500	720-3240	1500-10000
Cold or Warm Weather Series		4'	50	350 M	96- 360	200- 600	120- 480	250- 1800
20° to 42° gravity crude oils. Large water volumes, removable heat baffle. No excelsior section, outside siphon assembly, two manways, clustered external piping.	W-4	6'	50	500 M	192- 480	400-1300	240- 840	550- 4000
		8'	40	1000 M	360- 960	800-2200	480-1920	1000- 7000
		10'	40	1350 M	480-1200	1000-3500	600-2880	1500-10000
Similar to W-4 but with one excelsior section and three manways.		4'	50	350 M	120- 600	200- 600	150- 648	250- 1800
		6'	50	500 M	192- 840	400-1300	240- 960	550- 4000
	W-5	8'	40	1000 M	360-1680	800-2200	480-2160	1000- 7000
		10'	40	1350 M	480-2160	1000-3500	720-3240	1500-10000
Cold or Warm Weather-High Water Capacity		4'	50	350 M	Not Available	Not Available	120- 936	300- 1900
18° to 42° gravity crude oils. Large water volumes, heat baffle, multiple excelsior section, outside siphon assembly. Three manways.	C-1	6'	50	500 M			240-1200	600- 4300
		8'	40	1000 M			480-2400	1200- 7300
		10'	40	1350 M			840-3600	1700-10300

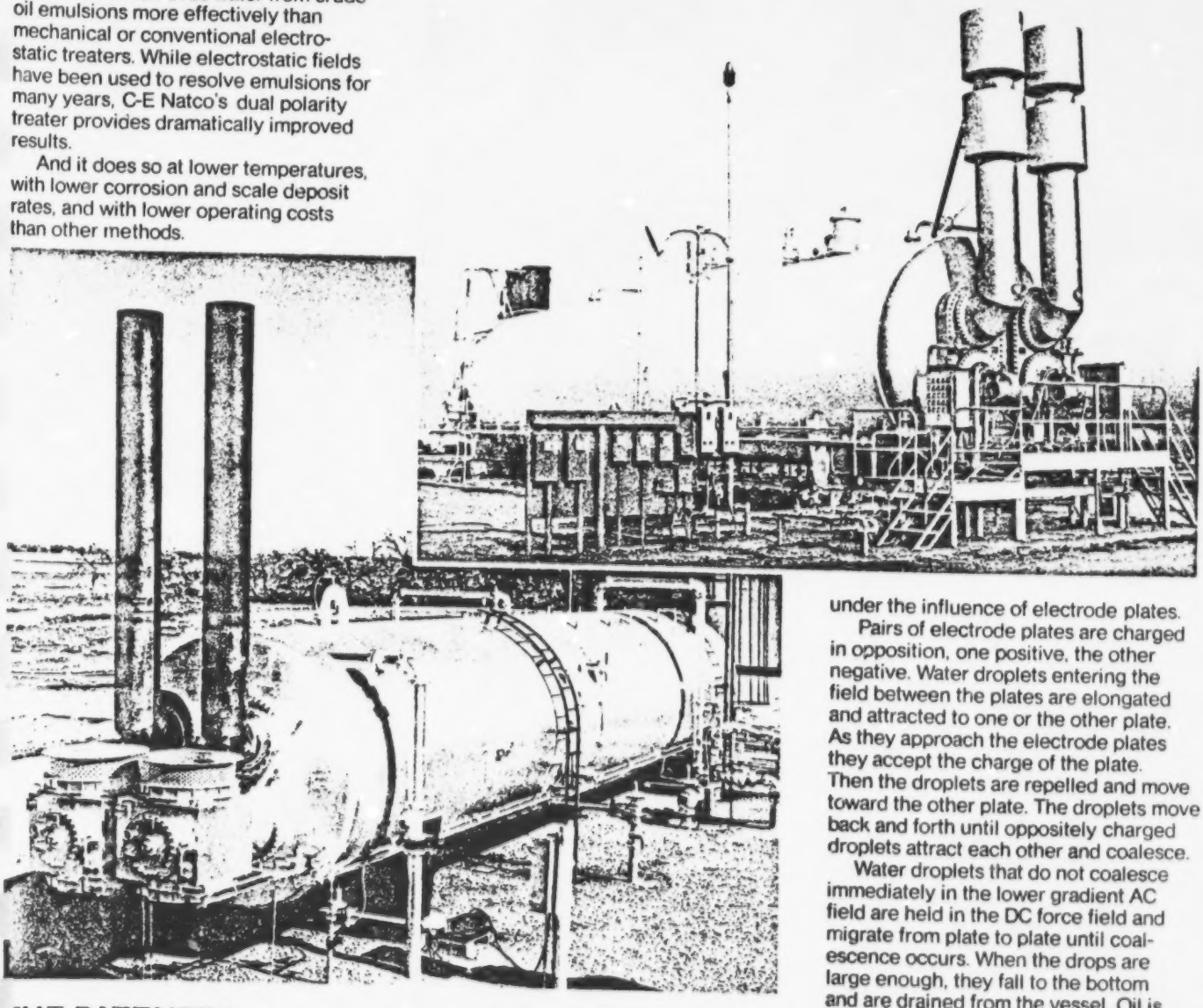
*Maximum gas-oil ratio is 1,000 scf:1 bbl


Another
C-E Natco
Idea at Work
DUAL POLARITY
ELECTROSTATIC
TREATER
Crude oil dehydration at higher rates
and lower operating temperatures.
NATCO
COMBUSTION ENGINEERING, INC.

INNOVATIVE CRUDE OIL DEHYDRATION

C-E Natco's Dual Polarity Electrostatic Treater removes water from crude oil emulsions more effectively than mechanical or conventional electrostatic treaters. While electrostatic fields have been used to resolve emulsions for many years, C-E Natco's dual polarity treater provides dramatically improved results.

And it does so at lower temperatures, with lower corrosion and scale deposit rates, and with lower operating costs than other methods.



THE PATENTED PROCESS
AC and DC currents accelerate coalescence

Free water and gas are typically removed from the process stream in free water knockouts and gas separators. However, some water often remains tightly held in the emulsion. In the Dual Polarity Electrostatic Treater water droplets are subjected to an AC/DC electrostatic field that causes them to coalesce and drop to the bottom of the vessel.

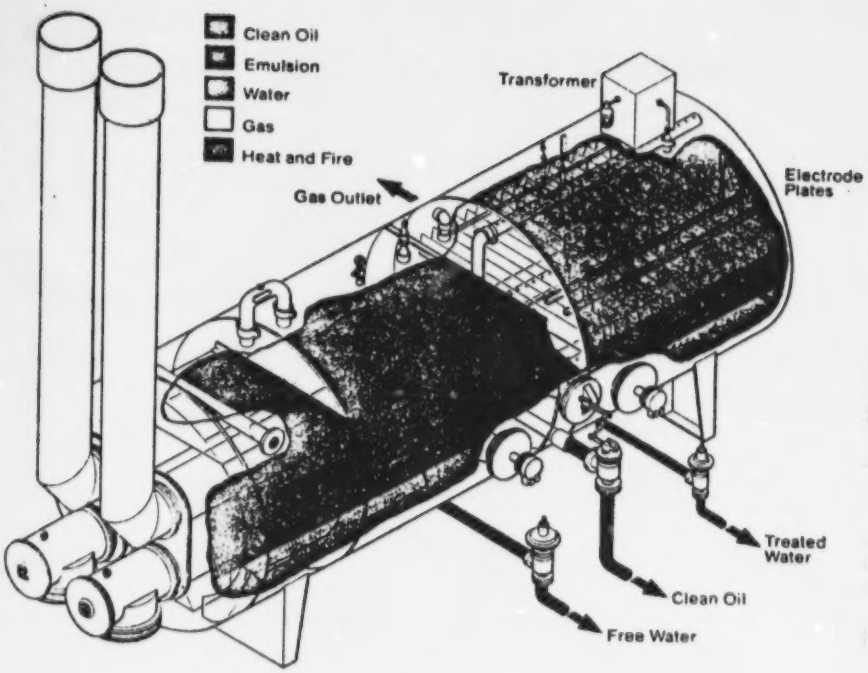
The crude oil emulsion flows through a C-E Natco VFH™ Vertical Flow Horizontal vessel with the dual polarity electrostatic internals. The emulsion enters the heating section where free water and gas separate. The oil flows over into the coalescing section and comes under the influence of electrode plates.

Pairs of electrode plates are charged in opposition, one positive, the other negative. Water droplets entering the field between the plates are elongated and attracted to one or the other plate. As they approach the electrode plates they accept the charge of the plate. Then the droplets are repelled and move toward the other plate. The droplets move back and forth until oppositely charged droplets attract each other and coalesce.

Water droplets that do not coalesce immediately in the lower gradient AC field are held in the DC force field and migrate from plate to plate until coalescence occurs. When the drops are large enough, they fall to the bottom and are drained from the vessel. Oil is recovered at the top of the vessel.

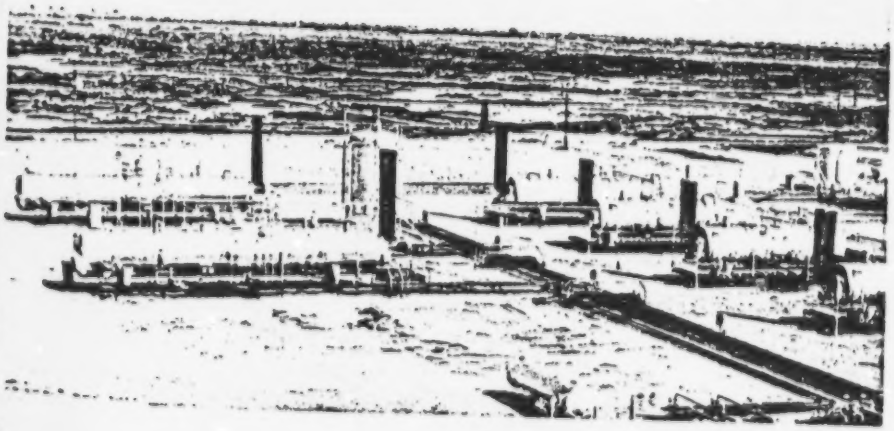
The electrostatic field is of several thousand volts. The transformer that supplies the field is designed to protect itself as well as other components of the system.

The DC field is self-regulating and supplies the maximum voltage for optimum resolution of the emulsion. The self-regulated field makes operation more economical with a minimum number of upsets.



CUSTOM TREATER DESIGNS
A full range of advantages

- Each treater is designed to specific requirements. Systems have been designed for a wide range of applications. Chemical aids can be used also, to boost efficiency.
- Less space is required with this system because vessels can handle much higher flow rates than conventional treaters. The units are ideal for offshore platform production, housed arctic operations, and for terminals where large volumes are handled.
- The Dual Polarity Electrostatic Treater is effective across the range of API gravities, even heavy crudes with gravities from 8° to 16°
- The system operates at lower temperatures, which results in fuel savings and reduced corrosion while still operating effectively.



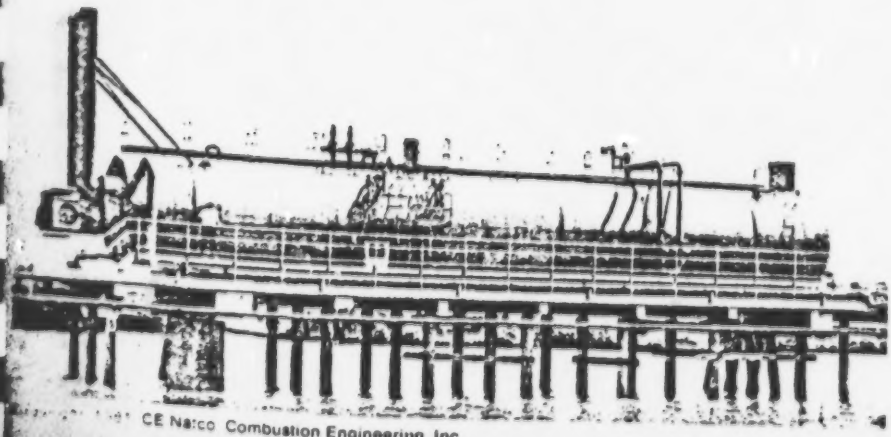
AN EXAMPLE INSTALLATION
Field Proven Systems operate reliably and save money.

C-E Natco Dual Polarity Electrostatic Treaters have been proven effective and economical in use at field production sites since 1971.

One unit was installed on a lease that produces crude emulsion which was difficult to dehydrate. The lease produces about 2000 barrels per day in oil with an equal amount of fresh water. C-E Natco's Dual Polarity Electrostatic Treater delivers 0.1 to 0.2 percent bs&w (basic sediment and water) at temperatures 20 to 25 degrees below that required for a conventional electrostatic treater.

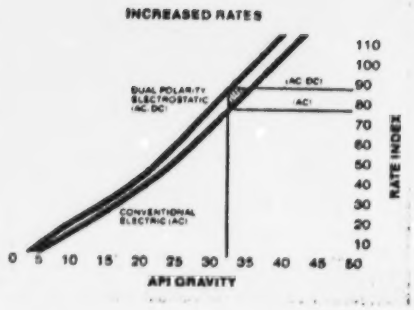
Three units replaced eight 10' x 37½' mechanical treaters in a crude oil dehydration system. These three C-E Natco Dual Polarity Electrostatic Treaters are processing steam-recovered 12°-13° API crude oil at a combined recommended capacity of approximately 15,000 bbls. of oil per day. The new units have reduced treating temperature requirements to 25 F less than previously operated units on the location for a year-end net fuel savings of $212,000. Since the units were installed in December, 1975, general maintenance cleaning has been reduced 50%. The units also produced cleaner discharge water with an 85% increase in oil removal.

Contact C-E Natco today and see how a Dual Polarity Electrostatic Treater can boost your profits. Or fill out the attached inquiry card for a proposal without obligation.

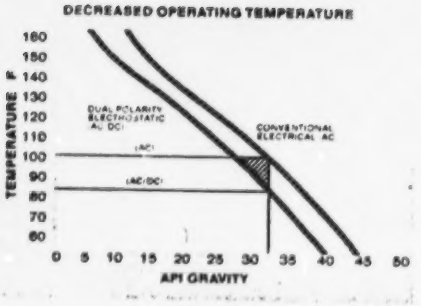


CE Natco Combustion Engineering, Inc.

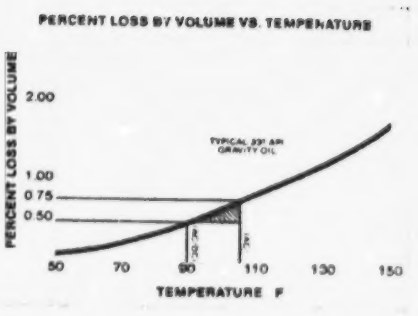
G-1260-A3



Increased Throughput Rates. With crude of any API gravity, the Dual Polarity Electrostatic Treater provides higher throughput than conventional electrostatic treaters. For example, with 32.5° gravity crude as shown, the throughput increase is 15%, up from 78 to 90. In production processing, higher throughputs mean higher profits.



Decreased Operating Temperatures. Because the Dual Polarity Electrostatic Treater processes crude of any API gravity at lower temperatures than conventional electrostatic treaters, it provides sizeable savings in fuel costs. The graph shows that, for 10,000 bopd, it achieves a 15° reduction in temperature on crude of 32.5° gravity. This 15° reduction can realistically produce a savings of 22,500,000 Btu/day. At 60% efficiency heat transfer, this can result in a fuel savings of 37,500 scf/day. At $2/Mcf, the savings is $75 per day for an annual savings on fuel of $27,375.



Percent Loss By Volumes vs Temperature. For 10,000 barrels of oil production per day, the 25% decrease in loss achieved with the Dual Polarity Electrostatic Treater means an increase of 25 barrels per day in production. At $32 per barrel, the additional income is $800 per day, or $292,000 per year. The Dual Polarity Electrostatic Treater operates at lower temperatures than conventional electrostatic treaters and achieves higher volume production for more profitable crude oil processing.

FOR MORE INFORMATION

For quotations or more information, contact C-E Natco:

Headquarters:
P.O. Box 1710
Tulsa, Oklahoma 74101 U.S.A.
Telephone 918/663-9100 • Telex 49-2427
Cable "Natco Tulsa"

U.S.A. Operations:
Regional offices in Bakersfield, California; Denver, Colorado; Harvey, Louisiana; Dallas and Houston, Texas.
Over 50 sales/service locations.

Worldwide Operations:

Canada:
C-E Natco Limited; Calgary, Alberta

Europe:
Natco U.K. Limited; London
C-E Natco France; Paris
C-E Natco Netherlands, B.V.; The Hague

Southeast Asia:
C-E Natco International, Limited; Singapore • Natco (Australia) Pty. Ltd.; Adelaide, Australia

Latin America:
Headquarters—6565 West Loop South, Suite 445. Bellaire, TX 77401 U.S.A.
Telephone 713/668-7551 • Telex 791937
C-E offices—Mexico D.F., Mexico; Sao Paulo, Brazil

Industrial Products Division:
More than 25 U.S. representatives, coast-to-coast. Contact Manager—Industrial Products Division, C-E Natco headquarters, for the representative nearest you. Telephone 918/584-5511.

Descriptions and specifications contained herein were in effect at the time this publication was approved for printing. C-E Natco reserves the right to discontinue products at any time or change specifications and/or designs without notice and without incurring obligations.

NATCO
COMBUSTION ENGINEERING, INC

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Telephone (918) 663-9100
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C-1260-A4

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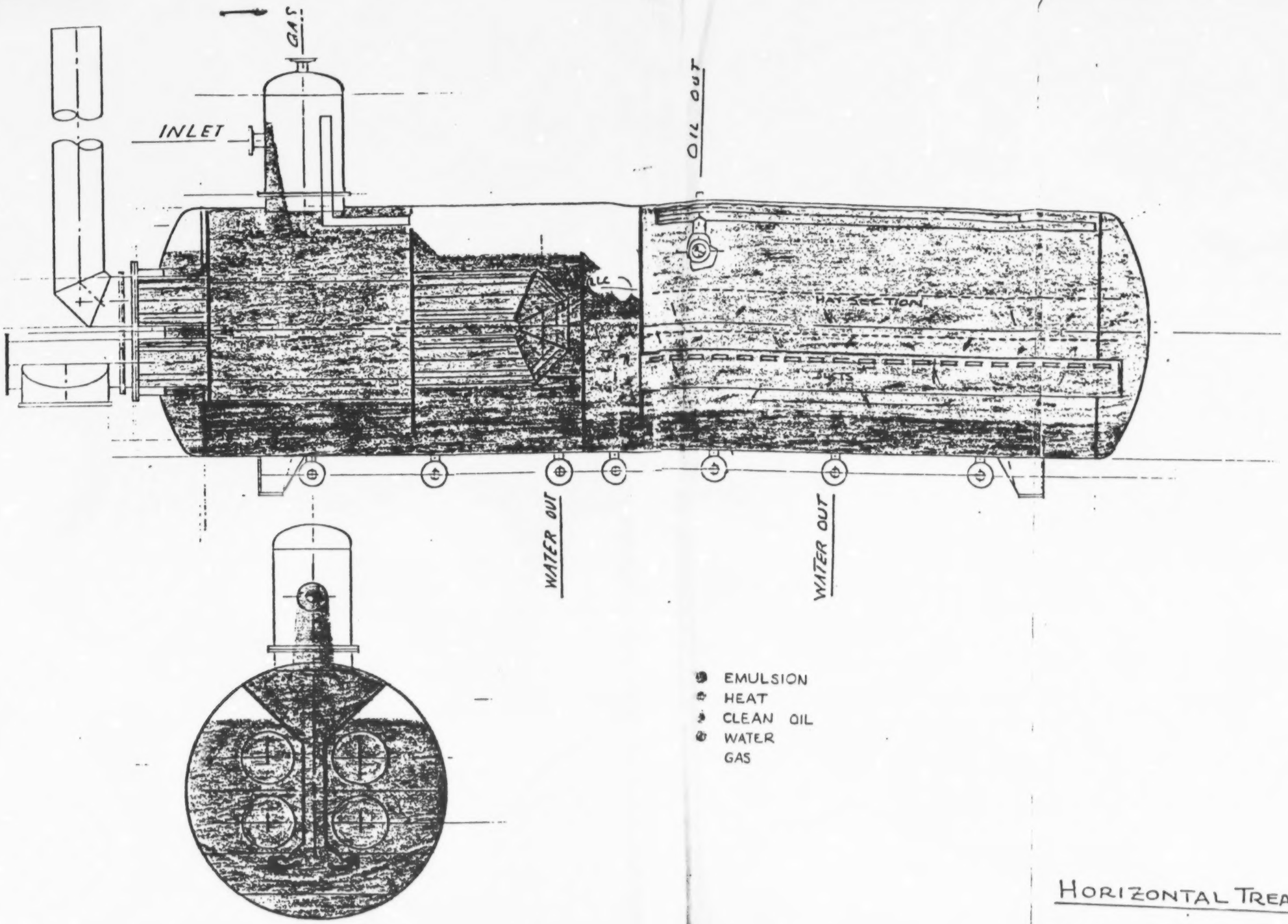

- EMULSION
- HEAT
- CLEAN OIL
- WATER
- GAS

HORIZONTAL TREATER

MALONEY STEEL LTD.
8325 SHEPARD ROAD
P.O. BOX 5008, STATION "A"
CALGARY, ALBERTA
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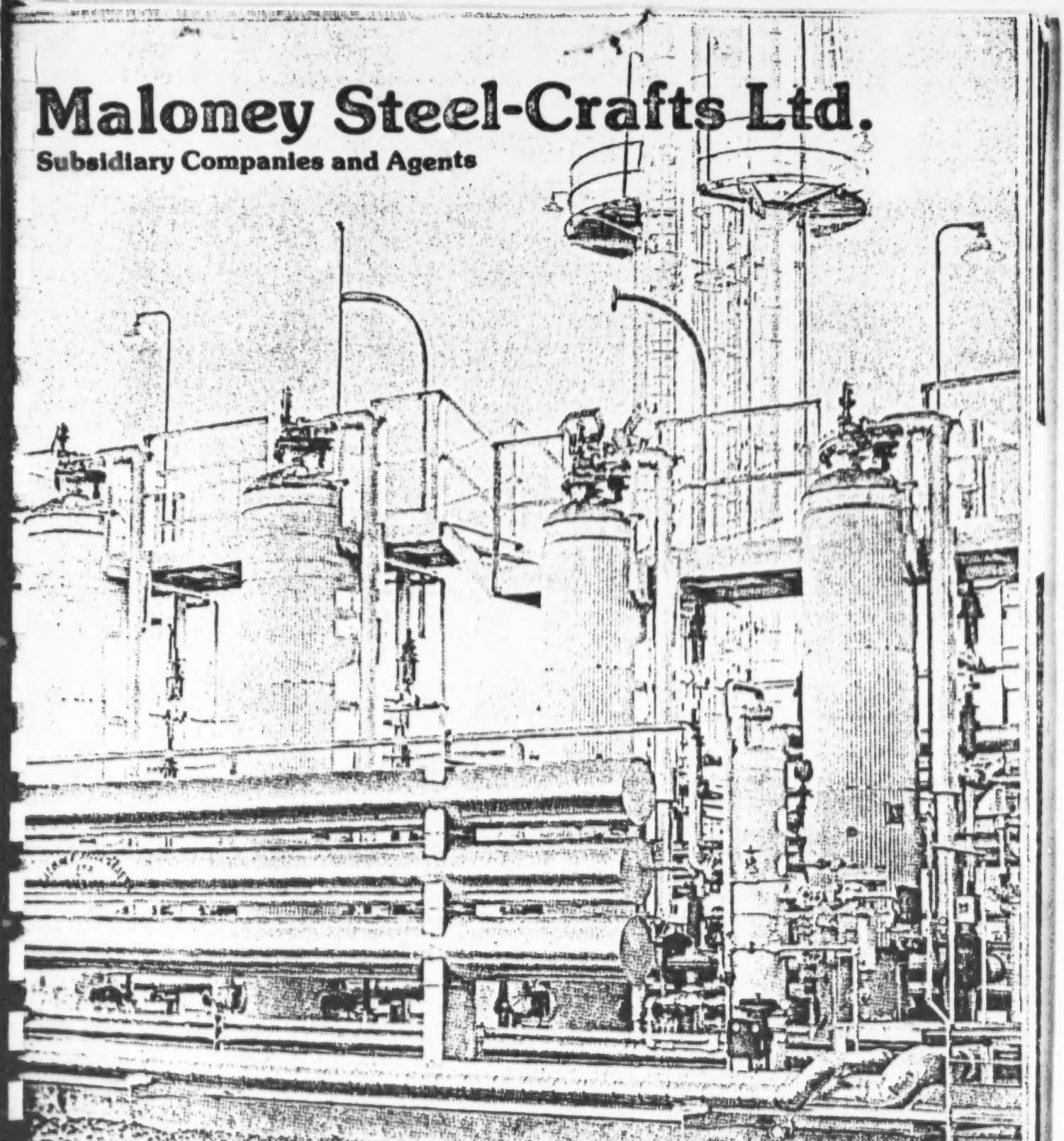
Maloney Steel-Crafts Ltd.

Subsidiary Companies and Agents



Serving The Oil Industry World Wide

GAS AND OIL DEHYDRATORS — HEATERS — SEPARATORS — OIL TREATING EQUIPMENT — GAS PROCESSING EQUIPMENT
SOLID DESICCANT UNITS — TANKS — PRESSURE VESSELS — CUSTOM FABRICATION

MALONEY STEEL LTD.

STREET ADDRESS
8825 SHEPARD RD S E
CALGARY, ALBERTA

MAILING ADDRESS P.O. BOX 5069, STATION "A"
CALGARY, ALBERTA T2H 1X1

TELEPHONE (403) 279-5541
TELEX 03-821153

PRODUCTS AND CAPABILITIES

Maloney Steel Ltd. is a totally Canadian owned and operated company with head office and engineering design facilities in Calgary. We have fabrication facilities in Calgary Alberta, and Kelowna, British Columbia. We also have a sales office in London, England (Maloney Steel-Craft (U.K.) Ltd. as well as agents and representatives in other countries around the world.

Oil and gas production and process equipment that have been designed and fabricated by Maloney Steel are operating successfully in the following countries all around the world: United Kingdom (onshore and offshore), Norway, Denmark, Egypt, United Arab Emirates, Abu Dhabi, Pakistan, Indonesia, Venezuela, Trinidad, United States and Canada.

Maloney Steel does the process, mechanical and instrument design engineering for each of its products. We provide the functional (performance) guarantee for the operation of the equipment we design as well as the mechanical warranty for the equipment we fabricate. All of our equipment is custom designed according to the customers' specifications and oil and gas application requirements.

Equipment products are often skid mounted and packaged with complete piping and instrumentation for complete operation.

Maloney has also supplied equipment for complete "turn key" installations with onsite erection supervision and commissioning. We have also provided training in Canada, for foreign personnel to operate the oil and gas equipment we supplied.

HEATERS - (Heat Oil and Gas)

a. Indirect bath type.
b. Indirect salt bath type.
c. Direct Fired bath type both non-code and code design for up to 150 PSI shell pressure.

DEHYDRATORS - (Removal of Water)

a. Glycol absorption.
b. Glycol regeneration.
c. Dry dessicant adsorption - natural gas, ethane, propane, butane.
d. Calcium chloride

cont'd.....

HYDROCARBON RECOVERY SYSTEMS - (Recover propane, butane, pentanes +)

a. Packaged Dry Dessicant.
b. Refrigeration.
c. Auto Refrigeration.

GAS SWEETENING SYSTEMS - (Remove Hydrogen Sulphide and Carbon Dioxide)

a. Amine.
b. Molecular Sieve.
c. Iron Sponge.

SEPARATORS - (Separate Oil, Gas, Water)

a. Vertical.
b. Horizontal.
c. Slug Catchers.
d. Sand Removal.

FREE WATER KNOCKOUTS - (Remove Large Volume of Free Water)

PRECIPITATORS - For produced water clean up.

FILTERS - Mechanical graded bed type for water clean up.

EMULSION TREATERS

a. Horizontal.
b. Vertical.
c. Electrostatic.
d. "Hay" Type.

COALESCERS - (Mechanical Separation of Liquids)

For special application in separating water from oil and condensate, Maloney has a special "Condensate Conditioner" which is highly effective in water removal from condensate and especially applicable where wet hydrocarbons often re-saturate dehydrated gas stream.

cont'd.....

SKID MOUNTED HEADER SYSTEMS

This covers many areas of skid mounted packages. We custom design to meet your requirements.

CUSTOM VESSEL FABRICATION

All types and sizes of pressure vessels.

CALGARY FABRICATION FACILITY

The Calgary fabrication shop and head office are located on a 15 acre site in the industrial section of Calgary. We provide engineering, design, fabrication, sales and service from this location. The shop floor area has 48,000 square feet of working space and is divided into two main working bays. Both bays are equipped with overhead cranes with a lift of 100 ton capacity in our heavy bay.

The craneway of our heavy bay is extended 120 feet beyond our enclosed facility and is used for moving in and out of both heavy plate and finished products. A rail line into this bay connects to our combination stress relieving and plate furnace at the west boundry of our property. The furnace is 13' wide x 12'-5" high (above rail car) x 48'-0" long, all inside dimensions. Only one end has a lift gate so that we presently can handle up to 96' overall vessel in two heats.

We have our own plate rolls capable of rolling 2.25" thick x 10' wide plate cold or 4.5" thick x 10' wide plate hot.

A certain amount of plate, in various thicknesses and grades is kept in our stock at all times. Special order of plate is normally obtainable from Canadian sources within 8-10 weeks. Heavy vessel heads are often imported from the United States.

The majority of our production is designed and fabricated to either ASME Section VIII, Division I Code or ASME Section VIII, Division II. Equipment has also been designed and fabricated in our Calgary facilities to the British BS 1515 Code.

KELOWNA FABRICATION FACILITY

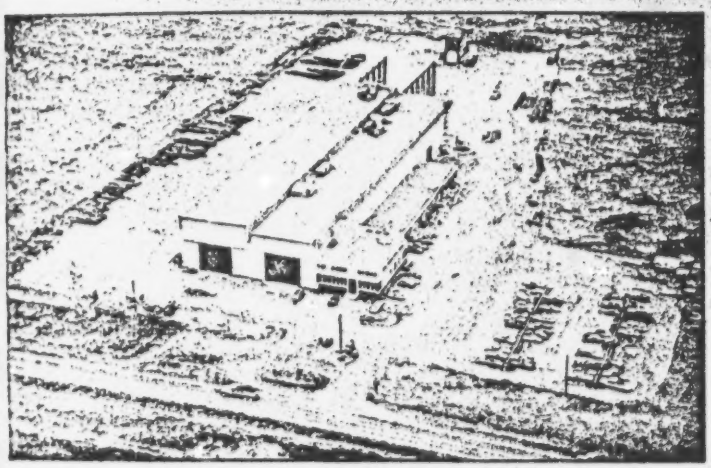
The Kelowna fabrication shop and office are located on an 8 acre site in the industrial sector of Kelowna. We provide fabrication, sales and service from this location. The shop floor area has 30,000 square feet of working space.

cont'd.....

There are three overhead cranes with a total lift capacity of 60 tons and are extended on a bridge 150' outside the building area. Plate rolls are capable of cold rolling 1 1/2" thick x 10' wide plates. Other fabrication equipment include automatic dual shield-submerged arc welding, hydraulic shears and breaks and mechanical presses.

The Kelowna shop is certified to design and fabricate pressure vessels according to ASME Section VIII, Division I Code. The facility has also fabricated a large amount of mining equipment (shutes, conveyors, hoppers, etc.), structural steel buildings and steel tanks.

MALONEY



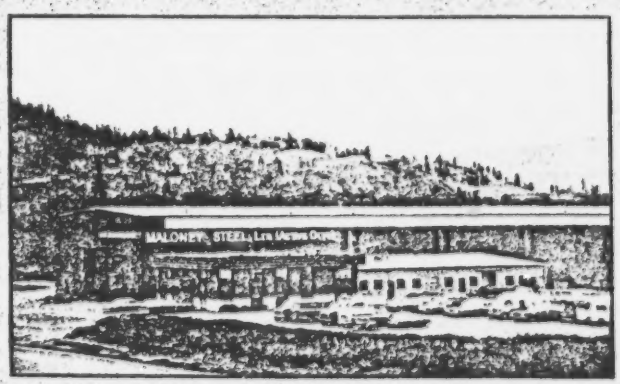
MALONEY STEEL
CALGARY HEAD OFFICE

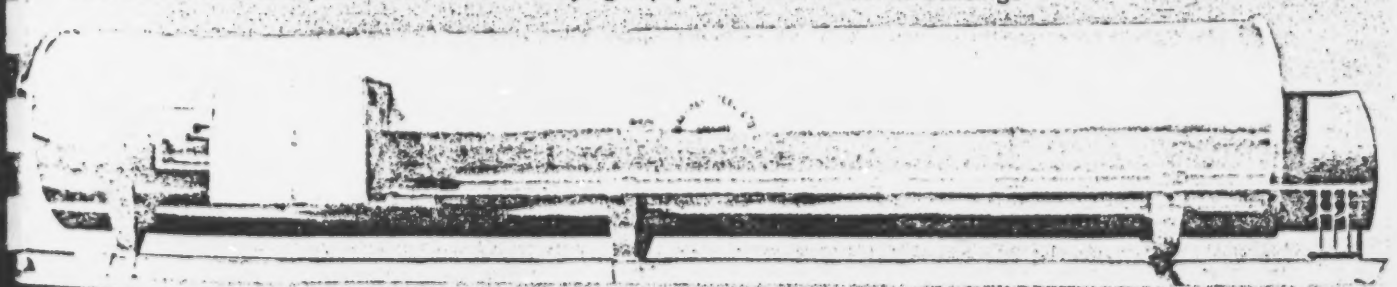
- Process and Mechanical Engineering Design
- Drafting, estimating, sales and service
- 48,000 square feet shop fabrication area
- Plate rolls for pressure vessels to 4.5 inches thick
- Automatic welding, plate cutting, rolls, overhead cranes
- Stress relieving furnace 13' x 13' x 48' long
- Pressure vessel design and fabrication to ASME Section VIII, Division I and II, Section I and Section IV codes
- Quality control stamps for ASME U1, U2, S and PP

MALONEY STEEL
KELOWNA BRANCH OFFICE

Branch Office - Engineering, Sales and Fabrication Facilities

- Mechanical engineering design
- Drafting, estimating, sales and service
- 30,000 square feet of shop fabrication area
- Plate rolls for pressure vessels to 1.5 inches thick
- Automatic welding, mechanical brakes, presses, hydraulic shears, overhead cranes
- Pressure vessel design and fabrication to ASME, Section VIII, Division I Code
- Quality control stamps for ASME U1, S and PP
- Structural steel fabrication to C.W.B Division I Code equipment and industrial buildings
- Steel tanks, structural plate work, mine conveying equipment, and industrial buildings





P.O. Box 5089, Station "A", 8825 Shepard Rd. S.E., Calgary, Alberta, T2H 1X
Telephone (403) 279-5541, Telex 03-821153
1855 Dilworth Drive, Kelowna, B.C. V1Y 8M
Telephone (604) 762-3131, Telex 048-5387

MALONEY STEEL CRAFT (U.K.) LTD.
Strand House, Great West Road,
Brentford,
Middlesex
Telephone 01-560 4191, Telex 935 428 MSC LTD

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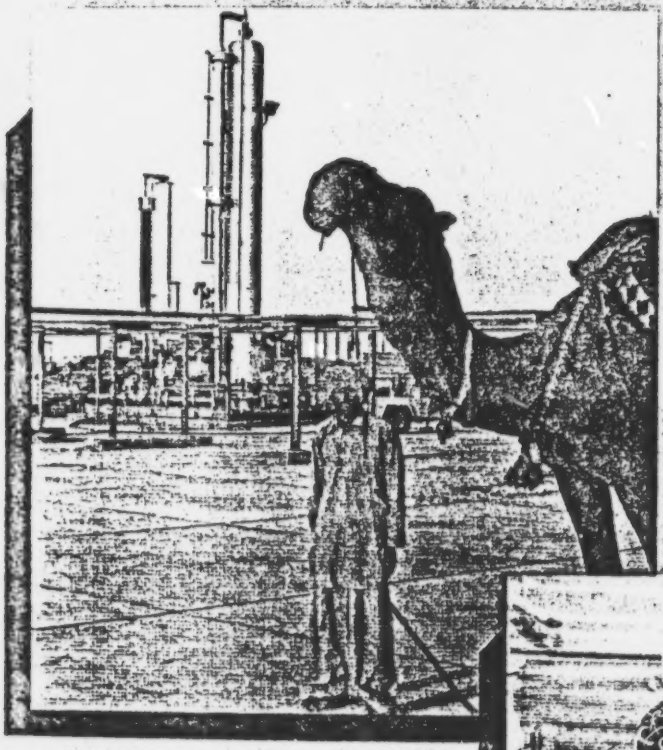

WE BUILD PLANTS IN PAKISTAN...

A

...North Calgary, North Colleen... ...Kananaskis, Fenn... ...Hinton, ... West Fox Creek, Eaglesham, Medicine River, Baptiste Lake, Blueberry Mountain and many, many more.

Process engineering is in house based on design procedures and computer data developed over the past 20 years.

Turn-key projects have been completed where Maloney engineers and designers have provided electrical design and process field installation, commissioning and operation services.

Packaging and design of skids for oil and gas processing and pipeline facilities. Maloney specialize in fabrication of ...

...Maloney Metalloy ...

P.O. Box 5069 Station 'A' MALONEY STEEL LTD. 8825 Shepard Rd. S.E. Calgary, Alberta, T2H 1X6
Telephone (403) 279-6541 Telex 03-821153

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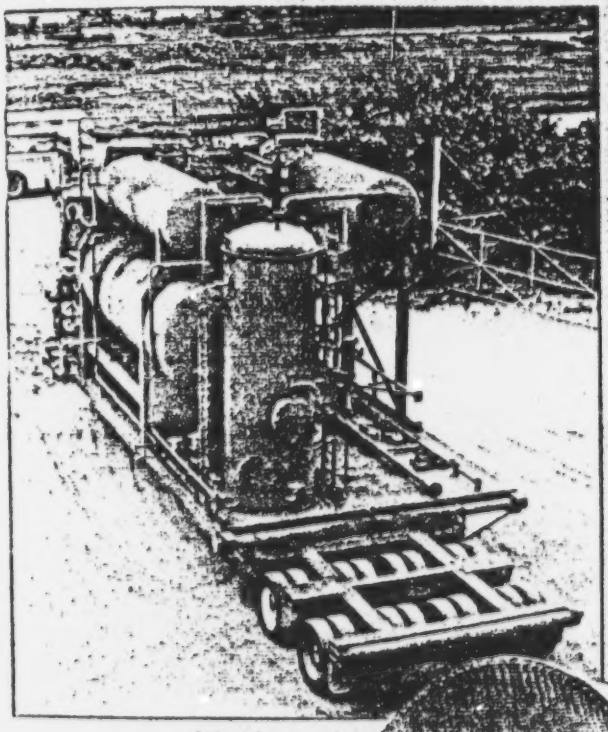


Maloney Steel
company
automa

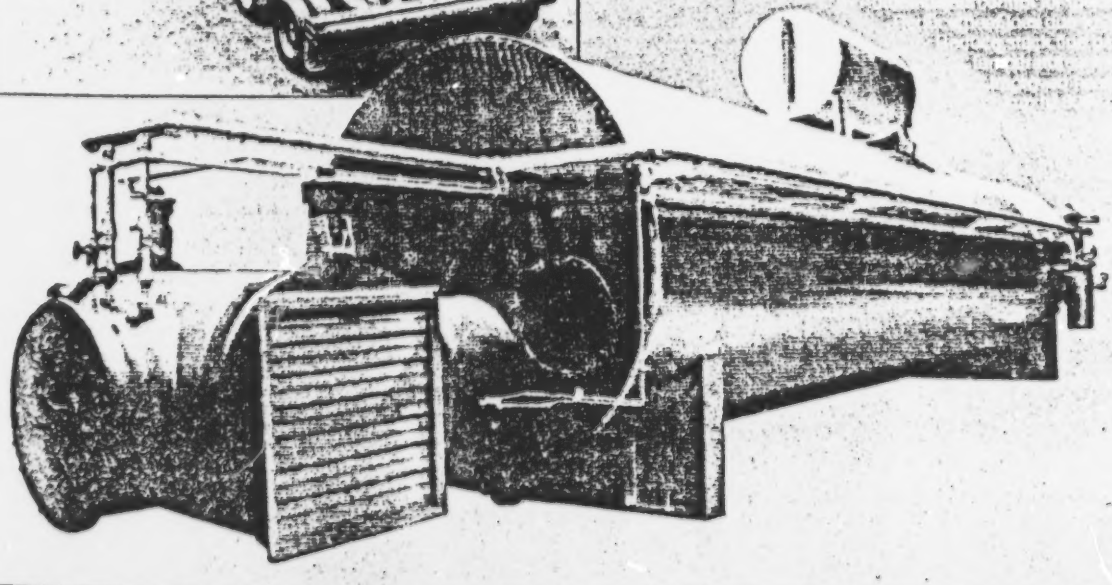
1) Engineering Design and Fabrication of Oil and Gas Production and Process Equipment

Dehydration
Glycol
Glycol
Desi

Heat
Heat
Wa
Heat

2) Gulf Hanlan-Robb Project

3) Maloney "Fuel-Savers" for Increased Efficiency of Fired Heaters



For additional information contact:

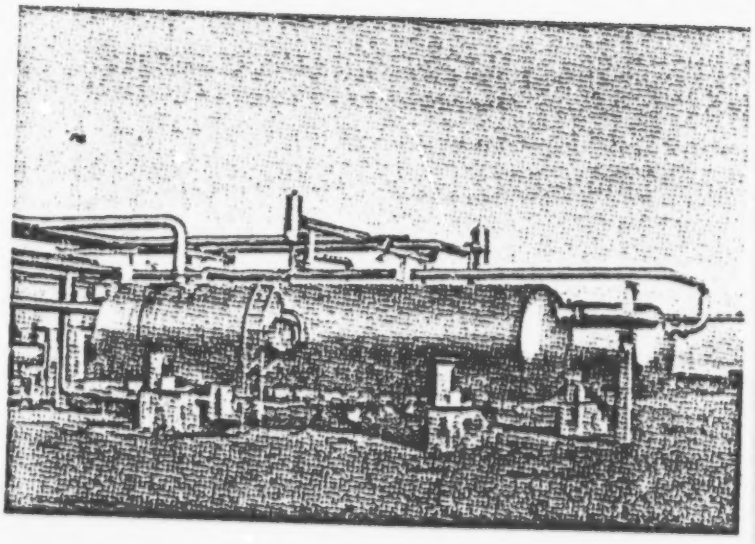
Maloney Steel Ltd., P.O. Box 5069, Station "A", 8825 Shepard Road S.E.
Calgary, Alberta T2H 1X1 Telephone (403) 279-55[illegible] Telex 03-82153

SEPARATION EQUIPMENT

The company designs and builds a wide variety of separation equipment for a number of end uses related to oil, gas and water separation.

Size varies from very small to as large as can be transported. Design pressures vary from 125 PSI to 3000 PSI.

Standard 2 phase (gas & liquid) separators and 3 phase (gas, liquid hydrocarbon and water) are available in both vertical and horizontal.



Maloney has available as a special feature an aerodynamically designed inlet de-energizer which greatly reduces the kinetic energy of the liquids entering the separator, thus minimizing carry-over, especially from slugs of liquids.

Foam baffling is also available as a special feature. For foamy crudes this baffling will reduce carryover as well as size of vessel.

CONDENSATE CONDITIONERS —

are a patented product available for removal of trace quantities of water from condensates.
These are mechanical and find use where condensates are recombined with dried gas and pipelined to a central plant or from an offshore platform to land.

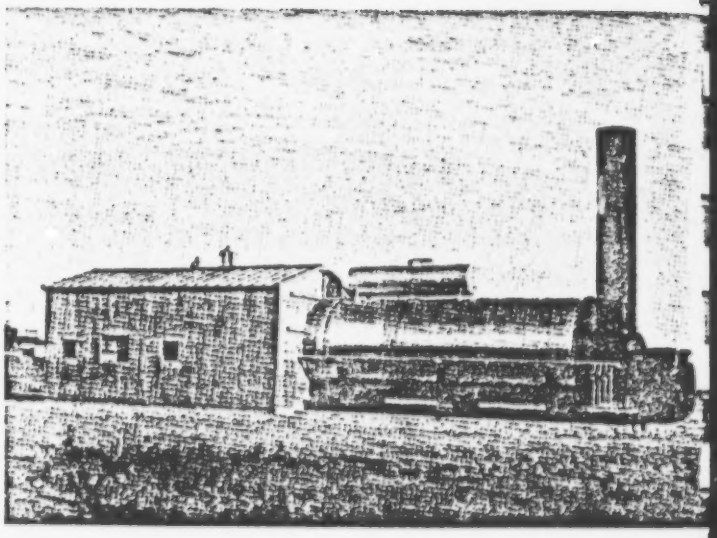
[illegible] —

for the removal of trace quantities of dust, chemicals, etc., from gas streams.

[illegible] —

for separating and splitting the flow to various downstream units such as treaters, heater, etc. These units have application in central treating facilities.

In southern Canada much of the natural gas contains hydrogen sulfide. To get the gas to a central treating plant, indirect heaters afford a means of transporting the gas which have definite advantages.

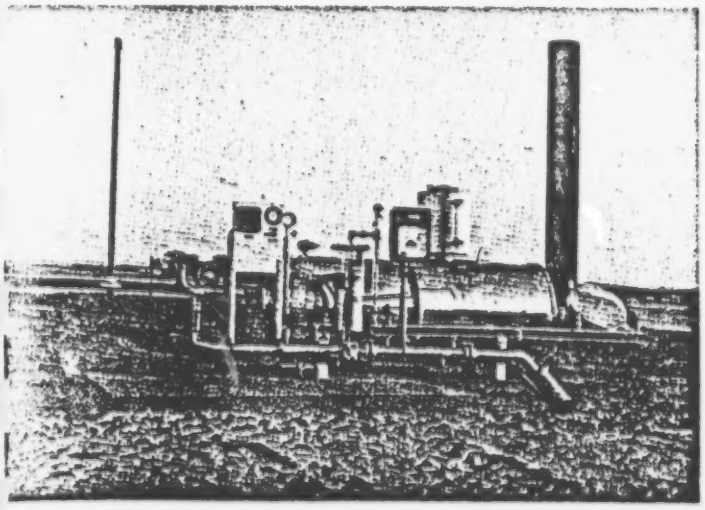


Units are available with coil pressure of up to 10,000 PSI. Maloney has built a wide variety of indirect heaters for heating gas and liquids. We have units in service imparting 10 million BTU per hour into the stream. We have units with streams of 150 MM SCFD.

Maloney has a "pull thru" bundle which permits housing one end of the heater for controls and metering.

Both the furnace and the coil (bundle) are removable.

The heater coils, unless standard, are designed for the required area, working pressure, pressure drop and specific application.



Units are available to heat, choke and reheat, as well as ordinary line heaters. Through wide experience we have acquired data on enthalpies on gas containing high percentages of H_2S and CO_2 at a variety of pressures.

Optional Extras — Skids, down-draft diverters for the stacks, flame arrestor, high temperature shutdown, fuel gas scrubbers, flame failure shutdown, "pull thru" bundles, high efficiency units, bath saver reservoir, special low pressure drop coils, coil designed for sour gas, automatic re-igniters.

[illegible]

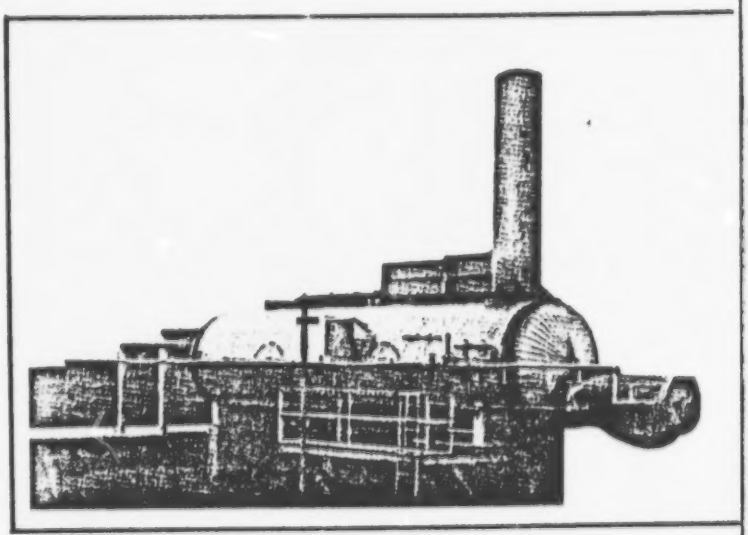
Where temperatures higher than can be obtained with an atmospheric water bath are desired we design and build:

1. Pressurized heaters — They are economical in the boiling point to 250° F range.

2. Heaters employing various liquid heat medias. Their economical range 212° F to 500° F

3. Salt bath heaters — For temperature between 300° F and 750° F

All of the above are available for pressures up to 10,000 PSI. All are available with removable bundles and firetubes.



[illegible]

These find application for utility heating.

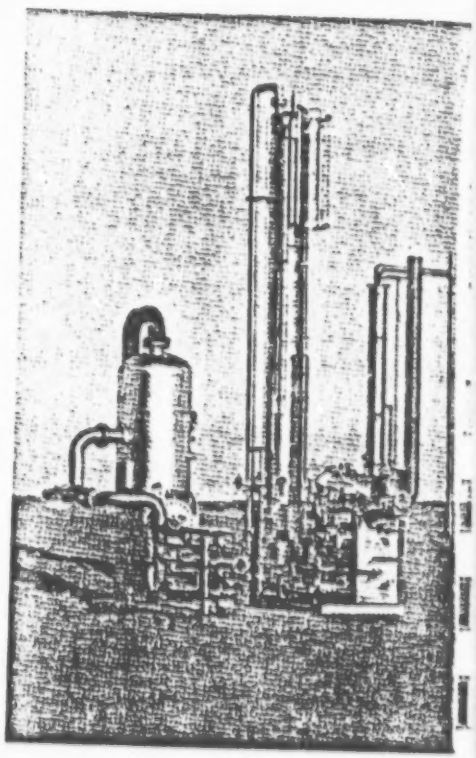
[illegible]

For rapidly vaporizing large quantities of propane.

GLYCOL DEHYDRATOR UNITS

For dry[illegible] gas, glycol dehydrators usually offer the lowest capital cost. The smaller sized unit can be completely packaged reducing field installation cost. Larger units can be packaged but some dismantling may be necessary for shipping.

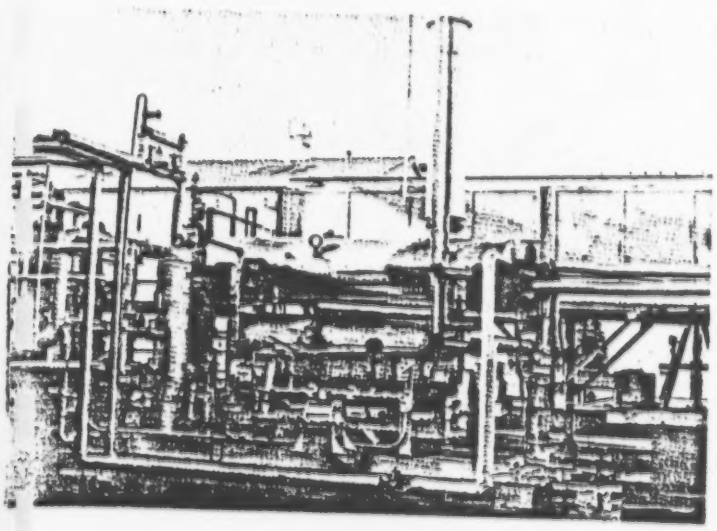
We have built units of sizes for throughputs of 1 MMSCFD to units with throughputs of 250 MMSCFD.



In Canada gas purchasers usually specify a maximum water content of 4 lbs. per MMSCF in southern areas and 3 or 2 lbs. per MMSCF for northern areas. We can design to any dewpoint desired within the limits of the process.

Standard features include:

A direct fired reboiler. We utilize a lower flux rate thereby reducing the possibility of glycol degradation and also increasing efficiency. Pneumatic (or gas) control throttling thermostat and fuel gas control valves are used to assure a finer control of the regeneration temperature and "fail safe" action. The distillation columns are generously sized and will tolerate some excess vapours. A glycol cooled reflux condenser is included whereby cooling is not left to atmospheric chance. Filters with bypasses are included.



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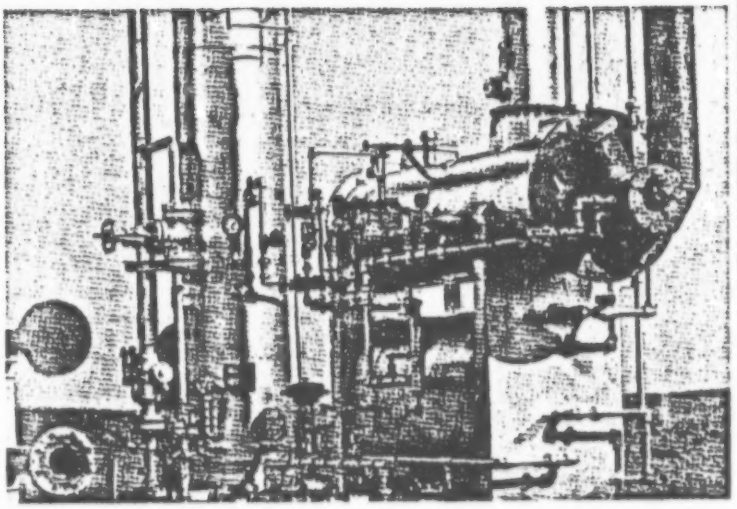


A two phase or three phase scrubber either integral or separate complete with controls and dump valves.

Glycol flash tank wherein hydrocarbons and or H_2S if present are flashed off.

Spare glycol pump with automatic switching if desired, high temperature shutdowns, flame arrestors on the reboiler, downdraft divertor on stacks, hydrocarbon skimmers, metering facilities, shutdown and alarm systems.

The glycol accumulator (surge tank) contains a glycol to glycol exchanger wherein the lean glycol is cooled by heating of the rich. This greatly reduces the heat requirement of the reboiler proper. On larger units Maloney splits these coils.

Pumps are powered by one of three means:

1. The rich glycol and makeup gas.
2. gas.
3. electricity.

[illegible] —

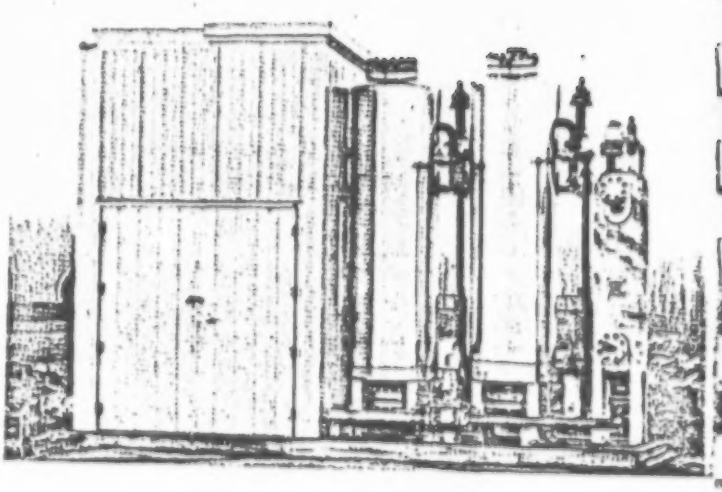
To regenerate ethylene glycol for injection in refrigeration plants. We have units from ½ gpm to 35 gpm. These units are available with both direct heating and indirect heat. Normally considerable heat exchange is incorporated which reduces the heat requirements and improves pump life. Glycol flash vessels are standard. The rich glycol is preheated before flashing and filtering to improve both functions.

SOLID DESICCANT DRYING

These units are multi-tower designed for unattended operation. Piping is based on computor calculated analysis to reduce thermal stress in the piping and distortion in the switching valves.

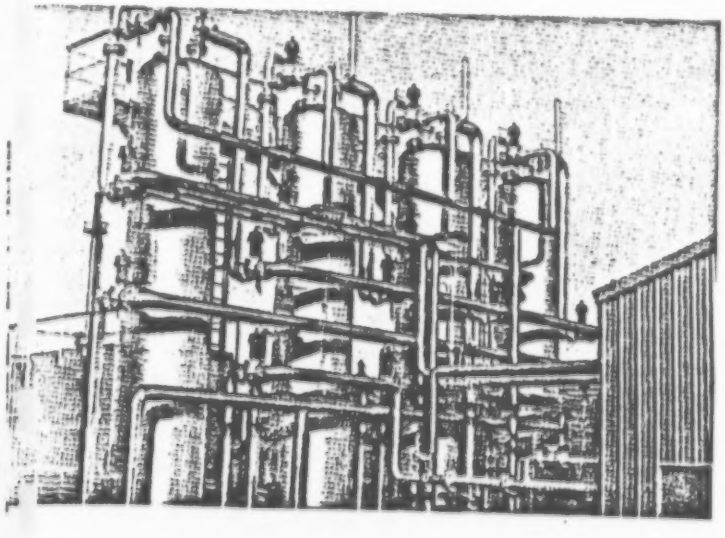
We have units in service:

1. For hydrocarbon and water removal.
2. For water removal from gas.
   A. For dewpoints to minus 150° F.
   B. For drying high H_2S streams to permit piping to central treating plants. In conjunction with Union Carbide we have coolerless units providing better on-stream performance and lower capital and operating costs.



3. LPG Drying — for removal of trace quantities of water from the LPG's in-plant or after underground storage.

These are custom designed and built to meet customer requirements.



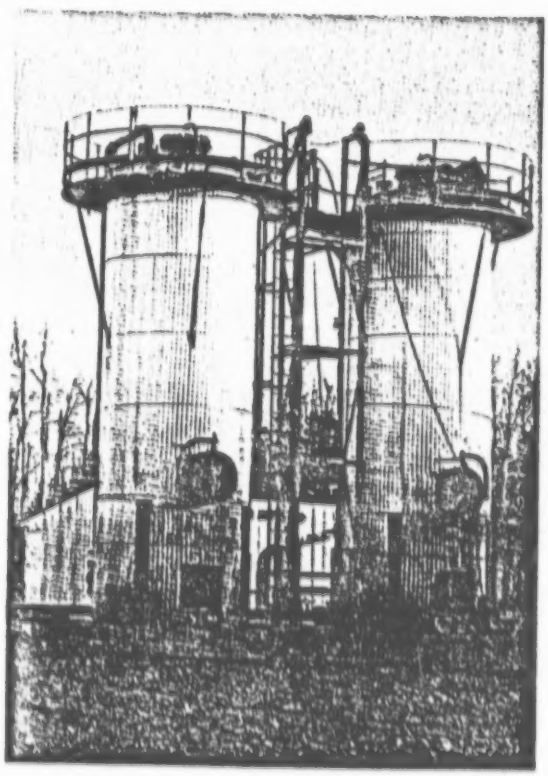
GAS SWEETENING UNITS

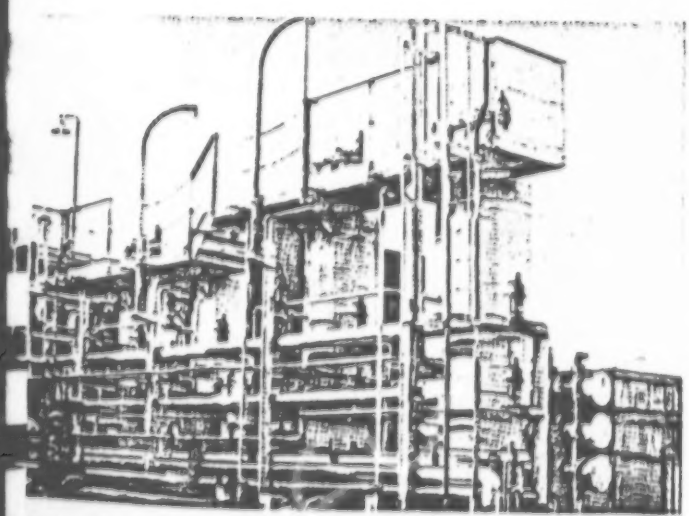
1. **AMINE SWEETENING UNITS** - we provide custom designed and built Amine sweetening units to remove hydrogen sulphide and carbon dioxide from natural gas. These are packaged for minimum field work. Usual design is for 1 grain max. per 100 SCF but lower H_2S content in the sales gas is obtainable.

2. **IRON SPONGE UNITS** - for natural gas streams with low hydrogen sulphide content we provide plants to remove the hydrogen sulphide.

3. **SOLID DESICCANT SWEETENING UNITS** for removal of hydrogen sulphide of intermediate H_2S strength.

4. **LPG. SWEETENING** - Maloney has in service units for sweetening propane and butane in the liquid phase.



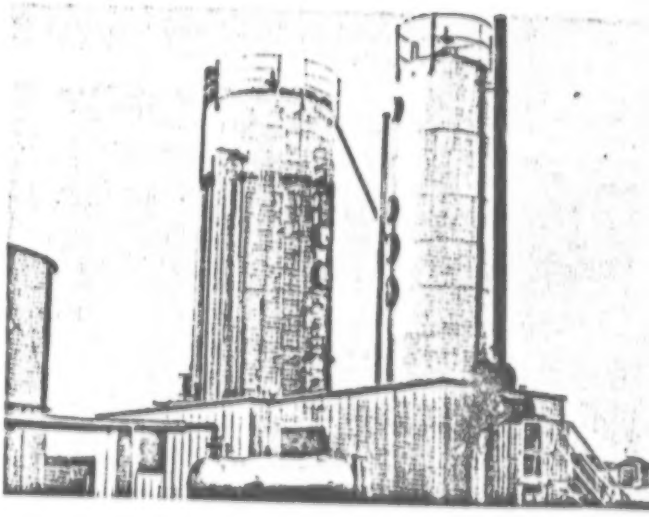


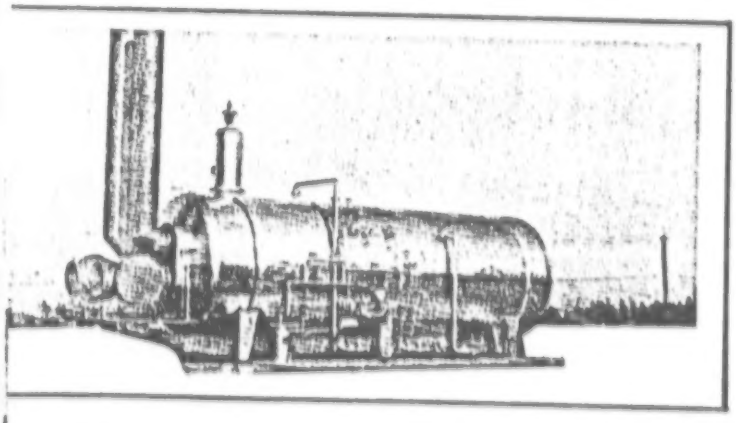
EMULSION TREATING

We offer a wide variety of emulsion treaters. Whether horizontal or vertical, conventional or electric coalescing, we can provide a unit specifically designed for your needs.

The basic purpose of all emulsion treating units is to treat the emulsion to pipeline specification, and in the process, provide gas separation and free water removal. From inlet to clean oil outlet, the basic functions performed are:

1. Initial degassing.
2. Emulsion preheating.
3. Free water removal.
4. Main heating and hot oil degassing.
5. Water coalescing and removal.





Vertical type treaters are normally limited to the smaller volume requirements. The diameter of the vertical treater limits how much firetube can be effectively employed and, too, the water, oil and gas volume are similarly limited.

For large volumes of oil, water and associated gas, the horizontal type treater provides the desired results.

Two types of Coalescing are offered:

MECHANICAL COALESCING

The "hay" type coalescing media is still most generally used and is very economical. When water wet, it aids in the coalescing of minute droplets of water which become large enough to drop, leaving clean oil for pipeline.

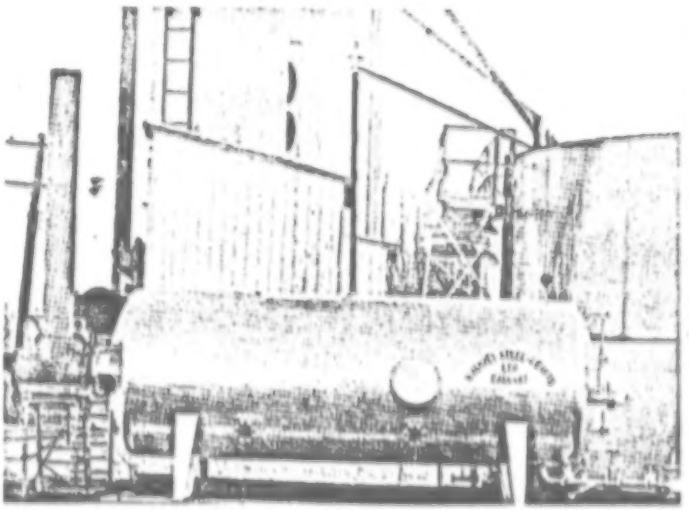
ELECTRIC COALESCING

Where electric power is available, it is often advantageous to consider the utilization of electric coalescing and precipitation of water. When a high voltage field is induced into a petroleum emulsion, the finely dispersed water droplets coalesce to form larger water particles which can then be readily removed by gravity. High voltage and low amperage provide an economical means of rapid water coalescing. We offer the electrical package including transformer, electric grids and associated items.

FREE WATER KNOCKOUTS

Whether horizontal or vertical, our Free Water Knockout provides dependability and satisfaction of operation. Where increased water production "crowds" the capacity of your treating facility, we offer custom design to meet your producing requirements.

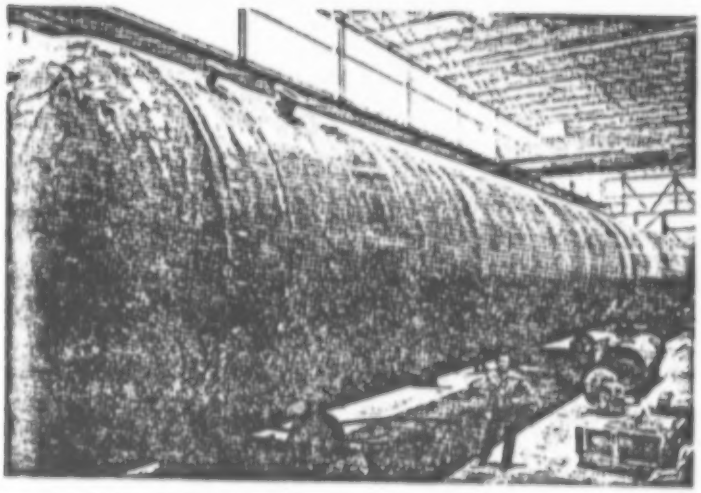
Free water knockouts are designed for either two-phase or three-phase flow. The normal two phase separation allows for removal of water only from the total production stream. The oil-gas mixture with associated water then proceeds together to the downstream emulsion treater for further processing to pipeline specifications.

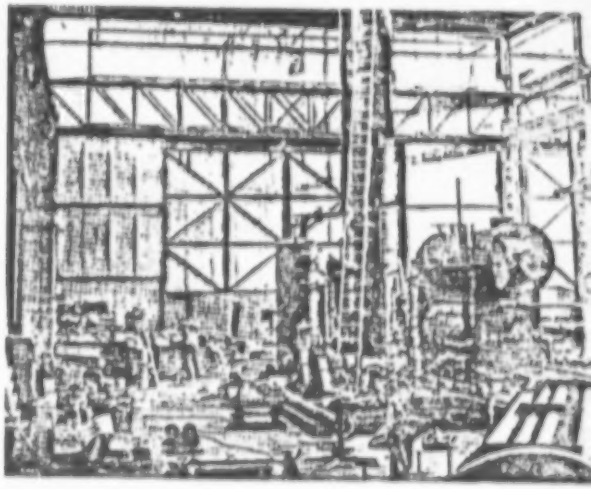


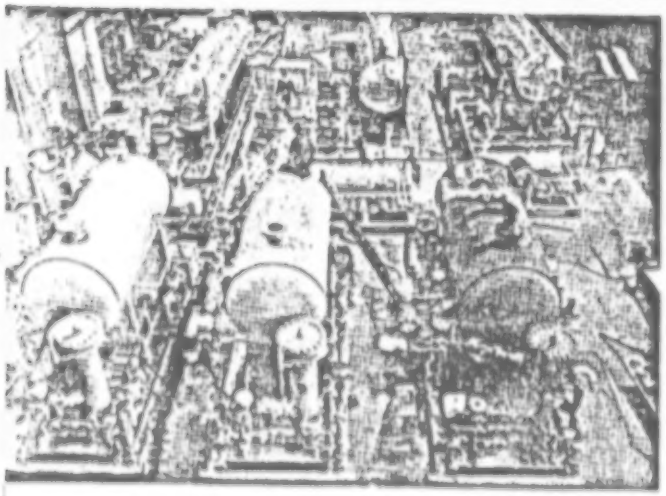
Where three-phase separation is required, all three components are drawn off separately.

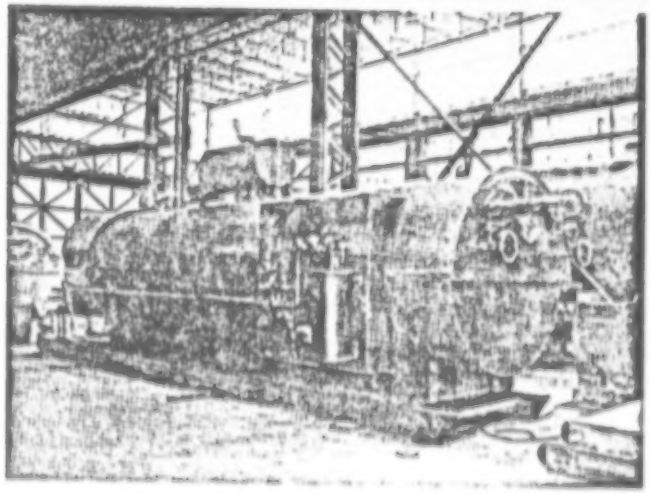
Heating of the incoming stream is often required to produce the desired results. Emulsions are often as much as 50% water with no free water present. By including initial heating, a large portion of this water becomes free, thus reducing the load on downstream treating equipment.

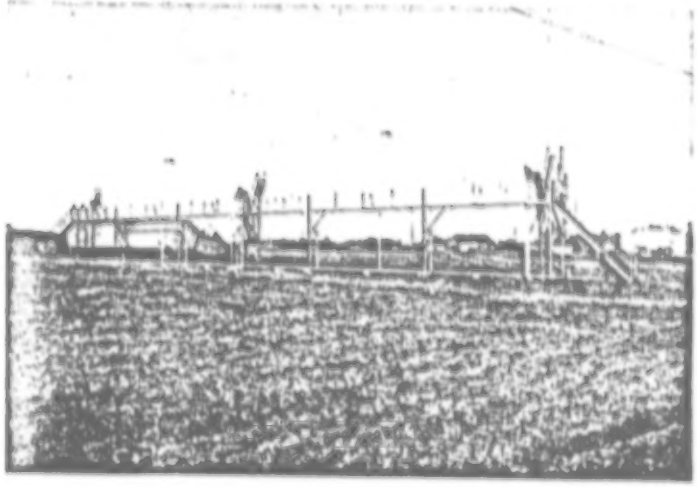
For the removal of trace quantities of oil from water.

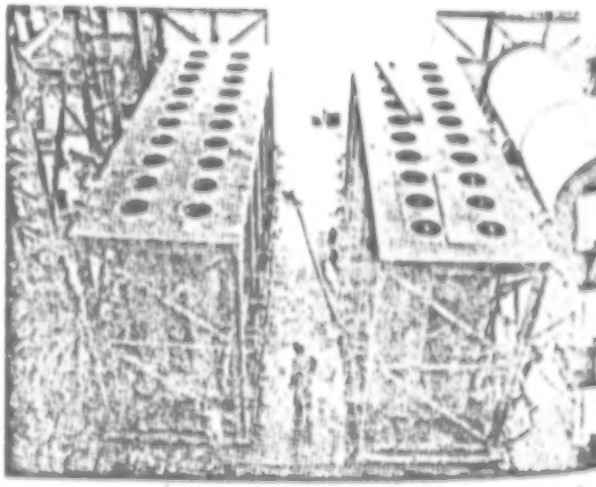












OTHER PRODUCTS

2. Low temperature Vessels

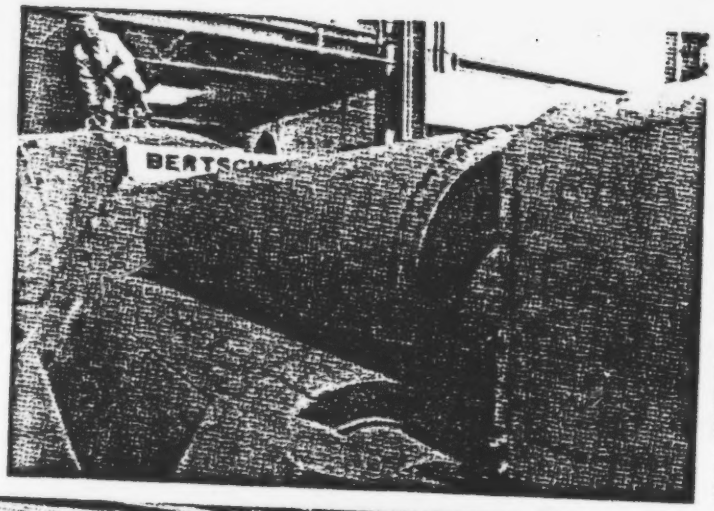
3. Tank Car Loading Racks

5. Flame Arrestors

6. Stacks

9. Safe line assemblies for multiple well testing

10. Blow cases for elevating pressure of liquids at compressor installations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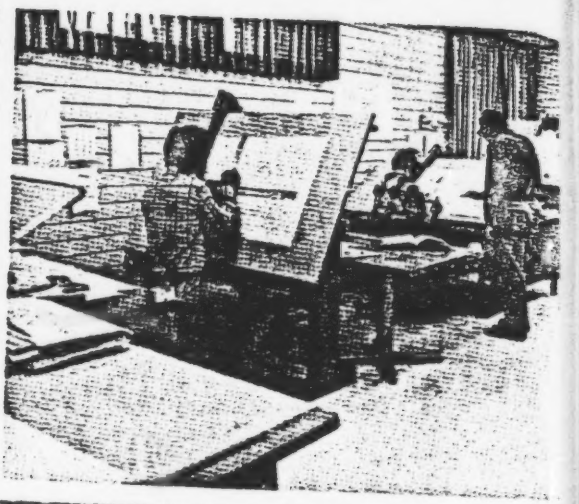

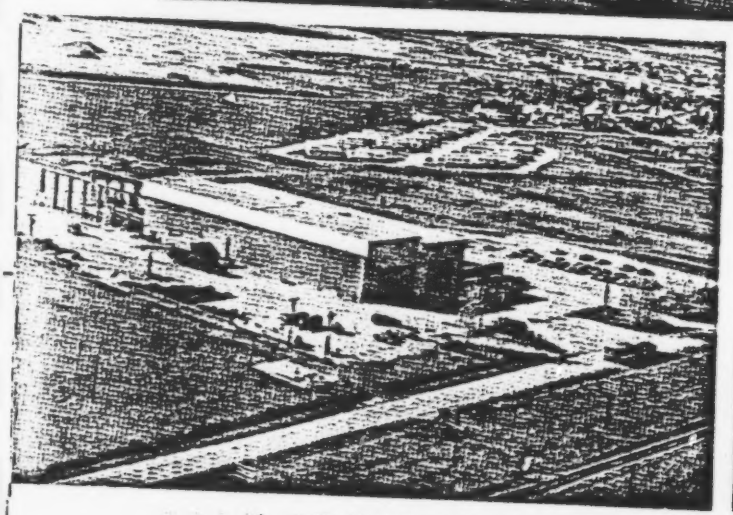

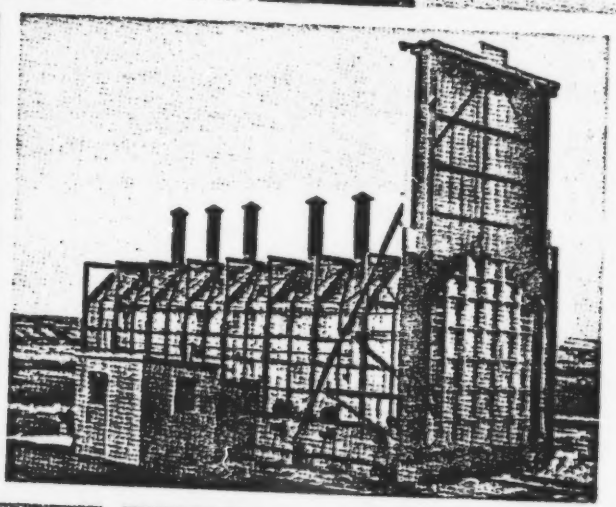

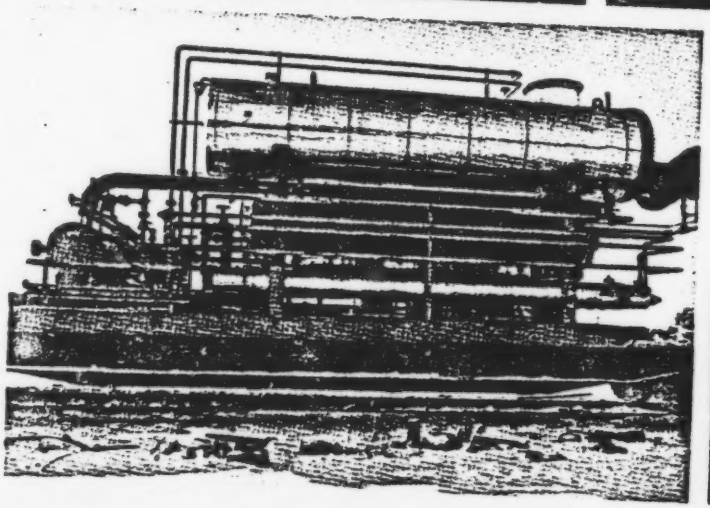

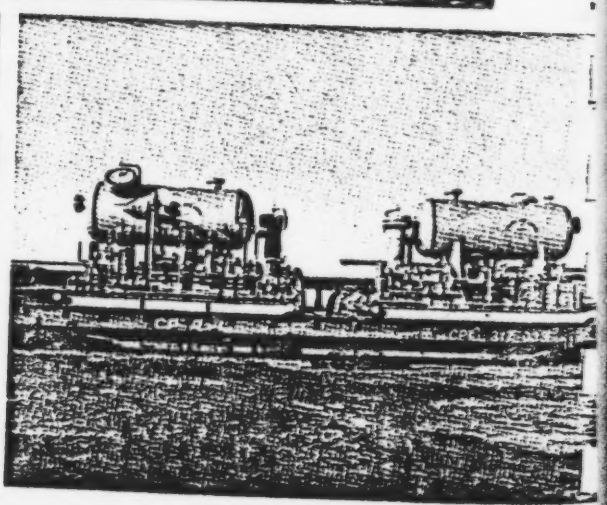

SERVICES

1. Stress Relieving
2. Hot Rolling
3. In-plant skid mounting modular packaging
4. Supply — via contract
5. Field installation — Canada only

The products, services, specifications and descriptions contained in this brochure were current at the time of publication, August 1976. Without notice, we reserve the right to change these products, services and specifications without obligation as improvements occur and technology improves.

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PRINTED IN CANADA
BY COMMERCIAL PRINTERS, CALGARY
DESIGN: BARBET DESIGN, CALGARY

APPENDIX D

TECHNICAL DEVELOPMENT DEPARTMENT BROCHURE

INTRODUCING

THE TECHNICAL DEVELOPMENT DEPARTMENT

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snc

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ATTACHMENTS

A. BROCHURE - THE SNC GROUP

snc

1.0 THE SNC GROUP

SNC is the largest integrated Canadian owned consulting and engineering firm. According to the Financial Post's 1981 list of companies in Canada, The SNC Group ranks as the 263rd largest industrial firm in Canada.

It has over 4,800 employees and carries out project management, engineering work of all sorts, and economic studies throughout Canada and the rest of the world.

Attachment A contains a brochure which describes, in detail, information about SNC as a company; its varied activities and some of the recent projects which it has carried out.

The SNC Group is an employee-owned Canadian company operating nationally and internationally. There are 377 individual shareholders. Over 97% of the issued shares are owned by Canadians.

Over the past few years The SNC Group has received approximately 650 assignments per year to perform services to government and industry. Many of these assignments are small as represented by an average billing of $200,000. These assignments are varied in character and spread across the many separate expertise centres of the company.

The company considers that its main strength is based upon that of its professionals, who are organized under product expertise centres in the following economic sectors:

- Power generation, transmission, and distribution
- Mining, mineral processing, and metallurgy
- Transport: airports, harbours, roads, and bridges
- Chemicals, petroleum, and petrochemicals
- Institutional, commercial, and residential buildings
- Environmental control
- Forest products, pulp and paper
- Telecommunications
- Light and heavy manufacturing
- Agro-industry

A Canadian pioneer in project management, the group has developed advanced skills and precise systems for the planning and control of complex projects, in every type of industry, from concept to initial operation.

Some of the companies within The SNC Group are very heavily research oriented such as:

- Arctec Canada Limited: applied cold regions research and development
- Robertson Research : geological services to the oil and gas industry

2.0 SNC'S TECHNICAL DEVELOPMENT DEPARTMENT

Some time ago, it was recognized by SNC management that, because of the energy crisis, a great deal of engineering work would be carried out in Canada during the next ten years on solid fuel processing. It was also recognized that the engineering companies, which will build the solid fuel processing plants, should have a hand in developing the expertise and know-how.

Therefore, SNC made the commitment to develop this expertise. A Technical Development Department was established on January 1st, 1979. Dr. Norman E. Cooke, the Chief Process Engineer is the Head of the new department. Dr. Cooke is a well qualified, broadly experienced process engineer and industrial chemist with a work history which includes plant operations, trouble-shooting, research, development, design, administration and management.

One of the main objectives of the Technical Development Department is to carry out research and development work on the conversion of solid fuels and related materials to other forms of energy.

SNC, and in particular the Technical Development Department, have made a commitment to research work in this area. To this end, SNC has a working agreement with Technitrol Canada Ltd., a medium sized commercial laboratory, which presently carries out chemical analyses and materials' testing. This laboratory is used as the process development laboratory of the Technical Development Department. Already its experimental work covers coal hydrogenation, catalyst development and pitch desulfurization studies in connection with the CANMET projects, which are mentioned below.

2.0 SNC'S TECHNICAL DEVELOPMENT DEPARTMENT (Cont'd)

The Technical Development Department has a staff of about 30 at the present time including the staff of Technitrol Laboratory. Six of the senior staff have Ph.D. degrees. In addition, the Technical Development Department is able to call in the large number of engineers throughout the company for specialist support.

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3.0 SNC'S PREVIOUS EXPERIENCE

3.1 GENERAL

This section briefly describes the projects which have been worked on in the Technical Development Department since its inception in 1979.

In addition this section also mentions certain other related investigations done by other divisions of the company.

3.2 EXPERTISE IN COAL AND RELATED AREAS

1) Technical Assessment of Coal Liquefaction Processes for Canada (1979-81)

This was a shared cost project undertaken with the Department of Energy, Mines and Resources to carry out a technical assessment of coal liquefaction processes under development throughout the world. The study involved collaboration with the various process developers. Samples of Canadian coals were evaluated in their experimental or pilot plant equipment.

The following coal liquefaction processes were considered:

- Saarbergwerke AG process (Germany)
- SRC II (Gulf Mineral Resources)
- H-Coal (Hydrocarbon Research Association)
- Exxon Donor Solvent (Exxon Corporation)
- Flash Hydropyrolysis (Cities Service Research and Development Co.)

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.2 EXPERTISE IN COAL AND RELATED AREAS (Cont'd)

1) Technical Assessments of Coal Liquefaction Processes for Canada (1979-81) (Cont'd)

- Supercritical Gas Extraction (National Coal Board - England)
- Solvent Extraction Process (Dow Chemical)

2) Saskatchewan Coal Liquefaction (1981/82)

This investigation was a techno-economic study carried out under a contract with SASKOIL-CANMET-PETRO-CANADA.

The study involved selection of the coal liquefaction process for Saskatchewan lignite from more than 20 processes being developed in the world. Two Saskatchewan coals (Estevan and Willowbunch) were considered for the study as feedstock to coal liquefaction plants. The study included:

- Review of state-of-the-art technology
- Evaluation of critical operating conditions for different types and rank of coals
- Conceptual design of self-sufficient, integrated, coal liquefaction plant
- Material and energy balances, on-site and off-site utility requirements
- Preliminary sizing of major equipment items
- Assessment of critical problem areas and technological uncertainties towards commercialization
- Economic calculations considering utility and private financing options in a commercial plant setting.

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.2 EXPERTISE IN COAL AND RELATED AREAS (Cont'd)

3) Ontario Lignite Liquefaction (1983/84)

SNC have begun work on a three phase project for the Ontario Ministry of Energy to assess the potential of direct liquefaction of Ontario lignite.

Phase I includes detailed laboratory assessment of fundamental analytical properties such as ultimate, proximate, petrographic and ash analysis of designated Ontario lignites.

Phase II includes review update, status and detailed technical assessment with preliminary cost estimates for prescreening, ranking and selection of a process for a designated Ontario lignite.

Phase III will require specific autoclave and lab tests by the "selected" process developer for preliminary process design and better cost estimates.

4) Fluid Bed Gasification of High Sulphur Coal with Carbonate Absorbents (1983)

SNC, in conjunction with Queens' University, have begun work on a pilot plant evaluation study for Energy, Mines and Resources, CANMET, concerning the suitability of fluid bed gasification with carbonate absorbents for the production of sulphur-free low calorific value gas from a high sulphur New-Brunswick coal.

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.2 EXPERTISE IN COAL AND RELATED AREAS (Cont'd)

5) Development of Spouted Bed Technology (1982)

A technology development study was carried out under a contract with Energy, Mines and Resources, CANMET. The study involved determination of the feasibility of designing a Process Development Unit (PDU), for the commercialization of Spouted Bed Gasifier technology. Two different design routes were adopted in scaling-up from a laboratory unit to a 12 t/d PDU - modelling with dimensionless analysis and mathematical modelling based on fundamental principles.

A mathematical model was developed to simulate the gasifier. The model predicts the concentration, velocity, and temperature profiles inside the reactor.

A preliminary design of the PDU facility was prepared and a potential plant site was chosen. Upon construction the PDU will be operated to experimentally generate the information needed to design a commercial unit.

6) Molten Salt Coal Gasification (1979/80)

This study was carried out for E.M. & R., CANMET, to investigate the feasibility of a molten salt coal gasification process to produce fuel gas from Canadian coals. Detailed thermodynamic calculations were done in order to design a unique "eutectic molten salts bath", which would not only gasify coal, but also retain most of the undesirable sulphur in the bath. An Interactive Computerized Program - FACT (Facility for the Analysis of Chemical Thermodynamics) was employed for phase equilibrium calculations.

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.2 EXPERTISE IN COAL AND RELATED AREAS (Cont'd)

7) Coal Gasification - Alberta (1977)

In 1977, SNC Tottrup Services undertook a coal gasification study to select the optimum coal gasification process for a commercial size plant in North Central Alberta. This study was commissioned by Shell Canada Resources Ltd. on behalf of itself and its partners to examine the feasibility of using coal deposits North of Edmonton Area, thus freeing natural gas for other users. Partners in this study included the Federal Government of Canada, the Provincial Government of Alberta, Pan Canadian Petroleum Ltd., Dow Chemicals Canada Ltd., Sherritt Gordon Mines Ltd., and SNC Tottrup Services Ltd.

8) James Bay Black Shales (1981/82)

Under contract with Société du Développement de la Baie James, SNC Technitrol Laboratory analysed a series of north Quebec black shale samples for oil and carbon content.

9) Coal Hydrogenation Studies, Removal of Oxygen from Coals (1981/82)

This investigation was an experimental program carried out under a contract with Energy, Mines and Resources, CANMET. It involved a systematic study to evaluate the effect of various inorganic reducing agents in removing oxygen prior to hydrogenation. A patent is being sought regarding the use of transition metal salts as catalysts for oxygen removal.

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.2 EXPERTISE IN COAL AND RELATED AREAS (Cont'd)

10) Development of Hydrogenation Catalysts (1981/82)

This investigation is an experimental program being carried out under a contract with Energy, Mines and Resources, CANMET. The study involves a systematic evaluation of the role of homogeneous acid catalysts for hydrogenation. The experiments are being carried out using model compounds having a similar structure to those present in hydrocarbon sources, such as coal, bitumen and heavy oils.

11) Desulphurization of Hydrocracked Pitch from Athabasca Bitumen (1981/82)

This experimental study was carried out under a contract with Energy, Mines and Resources, CANMET. The study involved pitch desulphurization using strong reducing agents other than molecular hydrogen. Certain of the agents tested remove a large fraction of the sulphur remaining in the bitumen.

12) Heavy Oil Upgrading (1977)

In 1977 SNC Tottrup Services undertook a comprehensive study to compare alternative processes for upgrading Lloydminster heavy oil. The study required that both capital and operating costs be developed for several combinations of alternatives. A linear program then chose the economic combination for each of the main upgrading processes. The clients were EM&R and the Saskatchewan Government.

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.3 EXPERTISE IN ENERGY FROM BIOMASS

1) Molten Salt Biomass Gasification (1982/83)

This project involves a design, experimental and technical-economic evaluation study to see whether it is feasible to use a molten salt bath to gasify biomass to make a synthesis gas suitable for manufacture into methanol. In one configuration there would be two pools of molten salt. One pool would be kept hot by injecting biomass and air into it. The biomass will burn and heat will be liberated to keep the pool of molten salt well above the melting point. The hot molten salt would be circulated to the other pool into which biomass and steam will be fed. In this second pool, the biomass will be gasified to form a synthesis gas, i.e. a mixture of carbon monoxide, hydrogen, water vapor and carbon dioxide. The second pool will cool as this reaction proceeds and the salt from it will be circulated back to the first pool where it will be reheated. Such schemes seem to promise the production of a clean synthesis gas containing no nitrogen, and without recourse to a liquid oxygen plant.

The design study is now completed and experimental work (undertaken in cooperation with Rockwell International) is about to start. This work is being funded by the ENFOR secretariat.

2) Biomass (Wood) Liquefaction (1980/82)

This 1980 ENFOR project study investigated the state-of-the-art of various methods for the liquefaction of biomass by chemical means, including direct hydrogenation, indirect

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.3 EXPERTISE IN ENERGY FROM BIOMASS (Cont'd)

2) Biomass (Wood) Liquefaction (1980/82) (cont'd)

hydrogenation by carbon monoxide and carbon dioxide removal by catalytic action under pressure. The study involved the selection of the best process together with the process design and factored cost estimation of such a large scale plant, also the process design and cost estimate of a pilot plant for ongoing investigations.

This work was updated in Autumn 1982 in a subsequent study undertaken for the National Research Council of Canada.

3) Fuel Alcohol (1980/81)

Preliminary process design and feasibility studies were made on behalf of Duncan Oil Co. of Georgia and Tennol Inc. of Tennessee, U.S.A. for plants to produce 25,000,000 gallon per year of corn-derived alcohol for gasohol fuel.

4) Methane from Pig Waste (1980)

A preliminary engineering evaluation was done for SISTCAN (Associates of Elf Hydrocarbures) regarding the "Pig Power" process of SGM Ltd.

5) District Heating by the Burning of Biomass (Sawdust) (1982)

A study has been conducted for Energy, Mines and Resources which established the feasibility of using sawdust produced at Papineauville, Québec to generate heat for district heating and other uses in the town.

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.3 EXPERTISE IN ENERGY FROM BIOMASS (Cont'd)

6) Electricity Generation with Wood-Fired Steam Engines (1981/82)

Through this ENFOR Secretariat contract, SNC determined the feasibility of steam engine power generation through the use of renewable biomass sources for remote communities and the adaptation and modification of currently available technology.

7) Work Done by the Environmental Division on Biomass Gasification (1982/83)

The Environmental Division has a project entitled "The Biosyn Project". This project involves the detailed engineering, procurement and construction of a large scale fluid-bed gasifier which will gasify biomass with the view to producing methanol from it. The gasifier will use oxygen to produce a medium Btu synthesis gas. The contract is being funded by Canertech and Nouveler. Canertech is a crown corporation set up by Petro-Canada to use venture capital to develop biomass utilization projects. Nouveler is a similar organization set up by the Quebec Government.

8) Gasification of Waste Cellulose (1975)

This was an engineering study for the Department of Environment of the Quebec Government to see if it was feasible to produce a reducing gas from waste cellulose for use by Sidbec-Dosco.

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.3 EXPERTISE IN ENERGY FROM BIOMASS (Cont'd)

9) Biomass to Methanol (1976)

An engineering study on large scale methanol fuel production from surplus Canadian biomass was undertaken for the Department of Environment in association with Intergroup Consulting Economists Ltd. (Sept. 1976).

3.4 OTHER SNC EXPERIENCE RE ENERGY CONVERSION PROJECTS

1) Hydrogen Economy (1981/82)

A Federal-Provincial government contract with Société du Parc Industriel et Commercial Aéroportuaire de Mirabel commissioned SNC to prepare two sectorial reports concerning:

a) Engineering requirements of ground facilities for envisaged trials of an intercontinental air transport network using Lockheed liquid hydrogen powered planes.

b) Utilization of electrolytic hydrogen in the Quebec economy, with particular emphasis on:

i) production of ammonia
ii) interaction with biomass exploitation
iii) reduction of ferrous and non-ferrous metal ores
iv) transport full or substitute natural gas
v) integration with oil refinery requirements

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.4 OTHER SNC EXPERIENCE RE ENERGY CONVERSION PROJECTS (Cont'd)

1) Hydrogen Economy (1981/82) (cont'd)

Subsequently, under the same contract SNC also prepared for PICA-Mirabel a project synthesis report regarding the role of hydrogen in the Quebec economy and integrating the findings of a dozen such commissioned sectorial studies.

2) Energy Storage Systems re Railway Electrification (1981/82)

Under contract to the Transportation Development Centre, SNC conducted a concept definition study of developing technologies in temporary energy storage as applicable to railway electrification, putting emphasis toward development of a system applicable to an electrification demonstration on the Quebec Cartier railway.

3) Stratified Charge Engine (1982/83)

SNC is executing a contract to study and assess the merits of modifying Ford and Chrysler engines to consume a variety of fuels in a stratified charge mode, at high efficiency.

3.5 OTHER SNC RESEARCH PROJECTS

1) Carbon 13 Isotope Production (1980/82)

SNC, in association with Thorne, Stevenson and Kellogg, appraised the business factors and potential of establishing laser chemistry carbon 13 isotope production by Canadian

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.5 OTHER SNC RESEARCH PROJECTS (Cont'd)

1) Carbon 13 Isotope Production (1980/82) (Cont'd)

Chemical Industry for the National Research Council of Canada. The Technical Development Department's role was to assess all the technical factors of the project including the design of the chemical processes involved and the estimation of the capital and operating costs.

2) Reverse Osmosis (1980/83)

This project, to perfect a reverse osmosis device invented by Dr. J. Mikhlin of SNC, is partially sponsored by an IRAP grant from the National Research Council of Canada.

3) Development of Hot Gas Venturi Scrubber (1982/83)

This work is being carried out under a contract from Energy, Mines & Resources, CANMET. It involves development of a computer model for designing an energy efficient hot gas venturi scrubber employing molten salts. The project program includes:

- Compilation of design information
- Specification of design criteria
- Mathematical modelling
- Creation of a computer program
- Simulation and testing of computer program
- Design
- Estimation of capital and operating costs

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.5 OTHER SNC RESEARCH PROJECTS (Cont'd)

4) Energy Conservation in Industrial Crushing and Grinding Circuits (1982)

This study was carried out under a contract with Energy, Mines & Resources, CANMET. It involved an in-depth survey of the literature on comminution in minerals processing industries. The existing and developing comminution processes were identified and their performance was critically evaluated. Problem areas were closely examined and process optimization techniques were presented.

5) Study of Particulates Emissions of Refineries (1982/83)

This study was carried out under a contract with the Petrolum Association for Conservation of the Canadian Environment (PACE). Catalyst particulates emissions by petroleum refineries were monitored to determine the level of adsorption of volatile organic and inorganic compounds. Particulates collected at high temperatures were analyzed for V, Ni, R, Se, Zn, Cd, Pb, Cu, Fe and Si and their surface chemistry is being studied in order to determine the impact of these particulates on theCanadian Environment.

6) Experimental Facility for Fuel/Air Explosives Research (1983)

SNC have been retained by the Defence Research Establishment Suffield Ralston, Alberta, to provide the facilities required for undertaking research work concerning fuel mist-air cloud explosions.

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.5 OTHER SNC RESEARCH PROJECTS (Cont'd)

7) Gasoline Production from Natural Gas (1983)

SNC is to undertake a shared cost project with the Department of Energy Mines and Resources, CANMET, to carry out a technical/economic assessment of the production of gasoline (and petrochemicals) from natural gas via acetylene.

8) Energy Potential of Thermal Difference Engines (1981/82)

In this study for the National Research Council of Canada, SNC examined the technical and economic feasibility of generating electricity for lake or sea-side Arctic Communities by exploiting differential water temperature effects.

9) Enersolve (1982)

In this study for Energy Mines and Resources, CANMET, SNC completed the pre engineering for a $2 million industrial demonstration project concerning the application of energy saving technology to the operation of a cement kiln. This study indicated that an ROI of 47 % could be expected, and that fuel savings of $ 41 million per year were attainable if this technology was applied to all Canadian cement kilns.

3.0 SNC'S PREVIOUS EXPERIENCE (Cont'd)

3.5 OTHER SNC RESEARCH PROJECTS (Cont'd)

10) Hydrodeoxygenation Investigation (1983)

In this study for Energy, Mines and Resources, CANMET, SNC will examine the effectiveness of two catalysts for the removal of oxygen from model compounds, representing coal pyrolysis or liquefaction heavy products fractions, by continuous high pressure vapour phase hydrogenation in a tubular packed bed reactor.

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